ACRP

REPORT 21

AIRPORT COOPERATIVE RESEARCH PROGRAM

Sponsored by the Federal Aviation Administration

A Guidebook for Selecting Airport Capital Project Delivery Methods

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AIRPORT COOPERATIVE RESEARCH PROGRAM

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A Guidebook for Selecting Airport Capital Project Delivery Methods

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), and the Air Transport Association (ATA) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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The research herein was performed under ACRP Project 01-05 by a team led by Northeastern University. The team consisted of Dr. Ali Touran of Northeastern University, who was the Principal Investigator, and two independent consultants, Dr. Douglas D. Gransberg of the University of Oklahoma and Dr. Keith R. Molenaar of the University of Colorado at Boulder. Payam Bakhshi and Kamran Ghavamifar of Northeastern University were research assistants and worked on various parts of this guidebook.

FOREWORD

By Gwen Chisholm Smith
Staff Officer
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ACRP Report 21: A Guidebook for Selecting Airport Capital Project Delivery Methods describes various project delivery methods for major airport capital projects. The guidebook also evaluates the impacts, advantages, and disadvantages of these various project delivery methods. The project delivery methods discussed include design-bid-build (DBB), construction manager at risk (CMR), and design-build (DB). The guidebook offers a two-tiered project delivery selection framework that may be used by owners of airport projects to evaluate the pros and cons of each delivery method and select the most appropriate method for their project. Tier 1 is an analytical delivery decision approach that is designed to help the user understand the attributes of each project delivery method and whether the delivery method is appropriate for their specific circumstance. Tier 2 uses a weighted-matrix delivery decision approach that allows users to prioritize their objectives and, based on the prioritized objectives, select the delivery method that is best suited for their project. The report will be helpful to airports with determining the most appropriate project delivery methods (e.g., DBB, DB, or CMR) for various types of airport capital projects.

With the increasing number of major airport projects (planned and underway) and the variety of project delivery methods available to complete those projects, guidance is needed to assist airport owners and operators with determining the most appropriate project delivery method.

The objective of ACRP Project 01-05 was to develop a guidebook to help airports evaluate and select the most appropriate project delivery method for major capital projects and evaluate the pros and cons of a contract for the project delivery method. To accomplish the project objective, the research team identified and described pertinent issues related to airport project delivery and provided analysis of the interactions of these pertinent issues with each project delivery method. The research team also interviewed project directors and financial planners at nine airports to learn how each project delivery method had been implemented on actual airport projects and to collect data relevant to each airport's project delivery and procurement process. In addition, the researchers developed a decision matrix to guide decision-makers on selecting the most appropriate project delivery and contracting method(s) in various airport environments.

A companion publication to this report, *ACRP Web-Only Document 6: Evaluation and Selection of Airport Capital Project Delivery Methods* reviews pertinent literature and research findings related to various project delivery methods for airport projects. It contains definitions of project delivery methods and discusses the existing selection approaches commonly used by airports. *ACRP Web-Only Document 6* can be found on the TRB website (www.trb.org) by searching for "ACRP Web-Only Document 6".

CONTENTS

SUMMARY

A Guidebook for Selecting Airport Capital Project Delivery Methods

Objective

A variety of project delivery methods is available to the developers of public projects in the United States. While the traditional design-bid-build delivery method remains the most common, there is considerable interest on the part of airports in alternative methods of project delivery and the potential of these alternative methods to save money and time.

The objective of this guidebook is to assist airports in evaluating and selecting the most appropriate project delivery method for their projects and in documenting this decision in a Project Delivery Decision Report. The guidebook is based on the fundamental premise that there is no *one* best delivery method for all projects, but that a project delivery method should be selected on the basis of each project's unique characteristics. This selection should be made by considering the advantages and disadvantages of competing delivery methods for the project under consideration.

The project delivery method is the process by which a construction project is comprehensively designed and constructed for an owner—including project scope definition; organization of designers, constructors, and various consultants; sequencing of design and construction operations; execution of design and construction; and closeout and start-up. With the rapid changes in procurement laws, public entities now share the ability of their private-sector counterparts to acquire construction services via alternative project delivery methods such as construction management, design-build, and other hybrid systems.

Research Methodology

The approach to developing the project delivery method selection framework was to synthesize relevant literature on project delivery methods and previous work in developing decision support systems for project delivery selection. In addition, face-to-face, structured interviews were conducted with nine airports to learn how each project delivery method had been implemented on actual airport projects. The report authors traveled to nine selected airports, interviewed project directors and financial planners, and collected data relevant to the airport's project delivery and procurement process. The results of the interviews were then incorporated into a set of pertinent issues. These pertinent issues are issues that were found to have a profound effect on the choice of project delivery method. These issues in turn were used to develop the project delivery method selection framework described in this guidebook.

Selection System Framework

A two-tiered project delivery selection system was developed that consists of the following components:

- Tier 1—Analytical Delivery Decision Approach and
- Tier 2—Weighted-Matrix Delivery Decision Approach.

The Tier 1—Analytical Delivery Decision Approach (Tier 1 approach) provides a framework for airports and their project delivery teams to define project goals and examine the advantages and disadvantages of each delivery method within the context of these goals. The aim of this approach is to help airports understand project delivery method attributes and to determine whether their specific project goals align with the attributes of a particular delivery method. The Tier 1 approach also provides a "go/no-go" review to determine whether one or more project delivery methods should be excluded from the examination.

At the completion of the Tier 1 approach, the user may not have a single, clear, and logical choice for a project delivery method. If this is the case, the user moves to the Tier 2—Weighted-Matrix Delivery Decision Approach (Tier 2 approach) with the best delivery method options from Tier 1 and creates a more detailed analysis to select the final project delivery method. The Tier 1 approach is designed as a simple and straightforward selection method. It is anticipated that users will find that the Tier 1 analysis is sufficient for most airport projects.

The Tier 2—Weighted-Matrix Delivery Decision Approach provides a means for a user to further examine delivery methods and document a project delivery decision for an individual project. The Tier 2 approach involves prioritizing project objectives and selecting the delivery method that best aligns with these objectives. In the Tier 2 approach, the user concentrates on a few key parameters affecting the choice of project delivery method, assigns appropriate weights to each parameter, and calculates a score for each competing delivery method. The process of selecting each parameter and assigning the proper weight is described in detail in this guide.

The selection system framework also provides the means to document a project delivery decision in the form of a Project Delivery Decision Report. The Project Delivery Decision Report will provide a transparent and defensible documentation of the decision process. This documentation is extremely important when explaining a project delivery decision to project stakeholders, particularly if an alternative delivery method is selected. The Project Delivery Decision Report was created to provide users with a rigorous documentation format while allowing for maximum flexibility in the choice of delivery method.

Regardless of whether one or two tiers are used to select a project delivery method, the selection system framework forces decision-makers to document their logic as they proceed through the process. This documentation will prove especially helpful to users when they have to make project delivery decisions in the future. The research team believes that this guidebook is a comprehensive resource for airports embarking on the process of selecting a project delivery method, providing guidance on how to select the most appropriate project delivery method and how to document the final project delivery decision in a concise and consistent format.

CHAPTER 1

Overview

Introduction and Purpose

The objective of this guidebook is to help airports evaluate and choose the most appropriate project delivery method for their projects. Another important objective of this guidebook is to help airports document the process of decision-making and the outcome in a Project Delivery Decision Report.

The project delivery method is the process by which a project is comprehensively designed and constructed for an owner—including project scope definition; organization of designers, constructors, and various consultants; sequencing of design and construction operations; execution of design and construction; and closeout and start-up. In some cases, the project delivery method may encompass operation and maintenance. Currently available project delivery methods have moved far beyond the traditional design-bid-build (DBB) method. With the change in procurement laws, public entities now share the ability of their private-sector counterparts to acquire construction services via alternative project delivery methods such as construction management, design-build, and other hybrid systems.

The researchers' approach to developing the project delivery method selection system was to review and analyze relevant literature on project delivery methods and previous work in developing decision support systems for project delivery selection. The research team recently completed a similar guidebook for transit projects (Touran et al. 2009). Experience and knowledge gained from that research helped in streamlining the research approach used in this project. In addition, an extensive questionnaire was developed for face-to-face, structured interviews with several airports. A list of airports was developed and approved by the project oversight panel (see Table 1-1). It was decided to consider only airports that had used alternative project delivery methods. Also, the team considered the geographical and capacity diversity of the airports to ensure that a representative sample was selected. The researchers traveled to the selected airports and interviewed persons in charge of selecting project delivery methods. In almost all of the interviews, the airport was represented by a team of individuals with planning, finance, and construction responsibilities for the capital programs at the airport. The results of the interviews were then analyzed and summarized (citations to the airport interviews are given in brackets throughout this guidebook). Based on the outcome of the literature search and the structured interviews, a set of pertinent issues was identified and studied. These pertinent issues are thought to have a profound effect on the choice of project delivery method. These issues in turn were used to develop the project delivery selection system described in this guidebook.

Table 1-1. Airports interviewed.

Case #	Airport (Three-Letter Code)	Project Delivery Method Experience*	Project Size Range Low/High (Typical)
1	Hartsfield-Jackson Atlanta Int'l (ATL)	DBB, CMR, DB	$1.0M/$1.2B ($10M–$20M)
2	Logan Int'l (BOS)	DBB, CMR	$10K/$165M ($2.0M)
3	Port Columbus Int'l (CMH)	DBB, CMR, DB	$50K/$165M ($1.5M)
4	Colorado Springs (COS)	DBB, DB	$200K/$36M (<$1M or $5–$9M)
5	Dallas/Fort Worth Int'l (DFW)	DBB, CMR, DB	$8.0K/$100M+ ($2M–$5M)
6	Denver Int'l (DEN)	DBB, CMR, DB	$500K/$150M ($2.5M)
7	Memphis Int'l (MEM)	DBB, CMR, DB	$100K/$20M ($5.5M)
8	Norman Y. Mineta San Jose Int'l (SJC)	DBB, DB	$2.0K/$185M ($4.9M)
9	Tampa Int'l (TPA)	DBB, CMR, DB	$50K/$80M ($2.5M)

* Project delivery method acronyms are the following: DBB = design-bid-build, CMR = construction manager at risk, DB = design-build.

Selection System Framework

Selecting a project delivery method is a decision that is based on a multitude of factors. In this guidebook, these factors are called "pertinent issues" and have been categorized as project-level issues, airport-level issues, public policy/regulatory issues, and other issues. The research team has identified and verified these pertinent issues through a literature search, extensive interviews with various airports across the United States, and discussions between the project team and the project oversight panel.

Based on these pertinent issues, the team has developed a two-tiered project delivery selection system that consists of the following: Tier 1—Analytical Delivery Decision Approach and Tier 2—Weighted-Matrix Delivery Decision Approach.

The Tier 1—Analytical Delivery Decision Approach (Tier 1 approach) provides a framework that can be used to define project goals and examine the advantages and disadvantages of each delivery method within the context of these goals. The motivation for this approach is to help users understand project delivery method attributes and determine whether their specific project goals align with the attributes of a particular delivery method. The Tier 1 approach also provides a "go/no-go" review to determine whether one or more project delivery methods should be excluded from the examination.

At the completion of the Tier 1 approach, the user may not have a single, clear, and logical choice for a project delivery method. If this is the case, the user is advised to move to the Tier 2—Weighted-Matrix Delivery Decision Approach (Tier 2 approach) with the delivery methods that survived the Tier 1 approach and create a more detailed analysis to select the final project delivery method. The Tier 1 approach is designed to be a simple and straightforward selection method.

The Tier 2 approach provides a means for the user to further examine and document a project delivery decision for an individual project. If a project delivery method is not found using the Tier 1 approach, the Tier 2 approach can be used to select a delivery method by prioritizing proj-

ect objectives and selecting the delivery method that best aligns with these objectives. The Tier 2 approach is based on successful delivery decision tools developed by academics and professionals over the past 20 years. With the Tier 2 approach, the user concentrates on a few key parameters that affect the choice of project delivery method, assigns appropriate weights to each parameter, and calculates a score for each competing delivery method.

Organization of the Guidebook

This first chapter of this guidebook provides an overview of the work accomplished and a road map for the guidebook user. Chapter 2 describes the characteristics of airport projects, presents the results of the literature search, and provides definitions of various delivery methods. Also, a summary of the existing methodologies for selection of an appropriate project delivery method is provided. In addition, recommendations are made for the appropriate point in a project lifecycle to adopt various delivery methods.

Chapter 3 describes pertinent issues affecting the choice of project delivery method and the advantages/disadvantages of each project delivery method in relation to these issues. There are numerous issues that airports need to consider when deciding to select a project delivery method. In this research, issues were identified through a literature search, personal experience, case studies, and interviews with airports. Pertinent issues are categorized as follows:

- Project-level issues,
- Airport-level issues,
- Public policy/regulatory issues, and
- Other issues.

These influencing issues and their interactions with different project delivery methods are presented in Chapter 3 in the form of a descriptive pro-con analysis. The analysis is based on trends found in the interviews conducted by the team with directors and executives at various airports and is supported by quotations from relevant literature.

Chapters 4 and 5 describe the Tier 1 and Tier 2 approaches, respectively. In order to facilitate and streamline the application of these approaches, blank versions of the tables from these chapters are provided in Appendices C, D, and E. The user can download these tables and go through the two tiers in sequential order (to find Appendices C through F for this report, go to www.trb.org and search for "ACRP Report 21"). Appendix A contains a list of sources that are referenced in this guidebook. Appendix B contains a glossary of important terms used in the guidebook (Appendices A and B can be found following the reference section of this guidebook). Appendix F provides a case study example of a major airport project for which the delivery selection system was used.

It is the report authors' belief that this guidebook is a comprehensive resource that can help airports select the most appropriate project delivery method and document their decision in a concise and easy-to-understand format. It is recommended that airports use outside industry professionals to facilitate implementation of the methodology contained in this guidebook. These professionals should have a thorough understanding of and experience with the type of project the airport is evaluating, the various project delivery methods the airport is considering, and the potential risks associated with the type of project and the project delivery methods under consideration. The use of such professionals will ensure that the appropriate expertise and experience is incorporated into the process. Facilitation of the process by outside professionals will also foster an objective selection of the most appropriate project delivery method, thereby minimizing the likelihood of a predetermined outcome.

CHAPTER 2

Literature Review and Definitions

Before embarking on describing various delivery methods, it is important to note the features of airport projects that distinguish them from other transportation projects because these features may have an effect on the selection process. Several types of project delivery method are currently available to the owners and managers of airport projects in the United States. It is important, especially in the case of large and complicated airport projects, to select the most appropriate project delivery method for a specific project. Contractual relations, contemporary laws and regulations, the project owner's perception of risks, procurement award mechanisms, and the method of payment are all factors in project delivery method selection.

It is important to note that this research in no way advocates one type of project delivery method over another. The expressed purpose of this effort is to assist airports in making the project delivery selection decision in a defensible and consistent manner. The report authors firmly believe that all project delivery methods can be used to successfully complete airport projects. Nonetheless, each project has unique characteristics that will make a given project delivery method the optimal one for project delivery. In the paragraphs that follow, alternative project delivery methods will be compared with traditional DBB project delivery, which functions as the benchmark against which all other methods are compared. A review of the literature suggests that the use of an alternative project delivery method can accrue benefits for project owners. However, the benefits of alternative project delivery methods presented in the literature occur most often across a population of projects rather than on an individual project. Thus, the reporting of benefits found in the literature should not be misconstrued as advocating one project delivery method over another. All project delivery methods have yielded both success and failure. Often failure is the result of selecting an inappropriate project delivery method.

Distinguishing Characteristics of Airport Projects

Wide Range in Size, Scope, and Cost

One distinguishing characteristic of airport projects is the wide range in their costs. There is a wide variety in airport projects; they consist of both horizontal and vertical projects ranging in cost from a few thousand dollars to megaprojects worth hundreds of millions of dollars. For instance, Logan International Airport projects have ranged in cost from $10,000 to $165 million over the past 5 years.

Security

Security consideration is another important attribute of airport projects. An airport's area is usually thought of as including two parts: "airside," which comprises runways and other facilities

beyond the terminals, and "landside," which includes an airport's interface with ground transportation (Reid and Brown 2007). Sometimes an airport's area is thought of as including three parts: airside, landside, and terminals (Transportation Security Administration 2006). The airside is a secured, non-public portion of an airport where movement of construction personnel and equipment is controlled. Further, access to the area adjacent to runways, taxiways, and gates is limited and under strict control. The terminal buildings, designed to accommodate the enplaning and deplaning activities of aircraft passengers, are the part of the airport with the highest level of security, safety, and operational requirements. The landside, excluding terminals, is a non-restricted area that includes area and buildings to which both traveling passengers and the non-traveling public have unlimited access. Construction in the secured zones of airports involves difficulties in providing security, which is time consuming and costly. Research has found that the cost of construction in areas beyond security checkpoints is 15 to 25% more than the cost of similar construction outside the secured area (Adrem et al. 2006). The reasons for this cost difference are numerous. Workers must be issued special security badges to enter the secure airside/terminal regions. This requires specific training and completion of a security clearance process, both of which take time. All vehicles and drivers have to get special licenses. Each morning, the workers are required to enter the secure zone via static security stations that may be remote from the work site. All materials trucks are not only security checked, but also escorted to the work site. Also, because of the presence of expensive aircraft and flammable material on the airside, the contractor must take into account various safety regulations that are not necessary in landside projects. All of these issues reduce the daily production rate of construction, adding time and money to the airport project.

Construction During Airport Operation

Airport projects are usually executed while airport operations are ongoing. Because of this, it is important to manage design and construction in a way that minimizes impact on airport operations. For example, construction work is often scheduled during periods of low airport activity. This usually means that much of the construction occurs at night (Adrem et al. 2006, Corey 2005). In some airports, like Los Angeles International Airport, a multiphased scheduling approach is tried that divides the project into phases and protracts the construction time to minimize delays to flight and passenger processing (Florkowski 2007a). The appropriate project delivery method should optimize available resources in achieving project goals in an active airport environment. Choosing the proper project delivery method can play a major role in minimizing the impact on airport operation and flight delays.

Complexity of Airport Projects

Airport projects are often complex: "Airport projects have a whole series of special systems which are seen nowhere else, on an enormous scale" (Merkel and Cho 2003). Some of these systems include sophisticated security devices (e.g., closed-circuit television, explosion detection systems, and X-ray scanners); electrical and data systems; special fire alarm and fire-fighting systems; and sophisticated baggage-handling systems. The spatial and circulation requirements of aircraft and related equipment and the crowds that ebb and flow throughout the day add complexity to airport design and construction. Some experts compare an airport to a body with multiple systems of interdependent organs; a failure in one system can shut down the entire terminal. Also, airports usually add or remove existing facilities instead of building a new one. This process causes problems such as establishing the terms of contract (allocation of responsibilities to project participants, especially the contractors) and ensuring that new additions are designed in a way that is compatible with existing facilities in terms of style and material. The challenge is to integrate the new and old facilities in an effective manner (Adrem et al. 2006).

Different Stakeholders

Due to the various activities conducted in an airport and the far-reaching effect of some airport projects on adjacent communities (such as construction of new runways or expansion of existing ones), there are many different stakeholders in an airport construction project. All stakeholders want to optimize the design based on their concerns, and these concerns are sometimes in conflict. Even in the airport proper, stakeholders' concerns can be in conflict. For instance, entities interested in the commercial aspects of airport operation may prefer a design that exposes passengers to as many stores as possible, while entities concerned with terminal operations may prefer that passengers take the shortest possible route through the airport. Different agents, with specific duties, who may not be responsible for a project's cost, make requisitions that may increase the cost of the project. The conflicting demands of project stakeholders can make it challenging for those in charge of a project to reach the needed agreements, and this may increase the design and development phase of the project (Adrem et al. 2006).

Type of Funding

Major airport financing comes from (1) federal assistance (FAA and TSA), (2) state assistance, (3) bond sales, and (4) airport cash and revenue funding (Airports Council International—North America et al. 2006). The Airport and Airway Trust Fund established by the Airport and Airway Revenue Act of 1970 provides the revenues used to fund the Airport Improvement Program (AIP), which assists sponsors, owners, or operators of public-use airports in the development of a nationwide system of airports adequate to meet the needs of civil aeronautics. In 1997, Congress enacted new taxes and funded the trust fund that guarantees a stable funding source whereby users pay for the service they receive. When aircraft operators are exempt from paying aviation taxes, their airport activity is not included in the justification or design for an AIP project (FAA 2005). Only those AIP projects considered by the FAA Administrator to be necessary to provide for a safe and efficient airport system and to meet the current and projected growth of civil aeronautics are considered for selection.

Although AIP can fund multiyear projects, the funds are released on a yearly basis and based on an agreed-upon payment schedule. Because of this, cash flow and compliance with an AIP-approved fund schedule have important roles. Using this fund causes restrictions like competitive pricing of construction services, compliance with the Davis-Bacon Act, and good faith efforts to include Disadvantaged Business Enterprise (DBE) firms (Airports Council International—North America et al. 2006). In fiscal year 2005, the total amount made available for the AIP program was $3,590,506,982. This budget provided 2,099 grants, ranging from $10,925 to $38,826,223, with an average value of $1,710,580 (General Services Administration 2008). For a typical AIP-funded construction project, the grantee and the FAA follow a designated process. However, based on the work involved, type of sponsor, project size, and so forth, some steps can be eliminated from this process. AIP funds do not require that accounting procedures be in accordance with the Federal Acquisition Regulation (FAR); for all federal aid that comes from TSA, grantees must follow FAR accounting procedures (Airports Council International-North America et al. 2006). Another source of funds is passenger facility charges (PFCs). These are taxes charged on each airline ticket, collected by the airlines, and given to the airport. The airport has to follow FAA guidelines in order to use these funds (such as using the funds for airfield-related or terminal-related projects).

State funding is another source of financing for airport projects. Many states assist capital improvement projects with grants through various programs. As with federal assistance, acceptance of this funding imposes restrictions and compliances. These can include restrictions on the type of contract and disbursement of the state's funds; competitive pricing of construction services; auditing and monitoring rules; required project record retention; involvement by the state

in an airport's selection process of professional consultant services; compliance with laws prohibiting job discrimination, the Davis-Bacon Act, the Civil Rights Act, and the Americans with Disabilities Act; and good faith efforts to include DBEs (Airports Council International-North America et al. 2006).

In bond-funded financing, factors like project definition, cost analysis, budget commitment, and delivery schedule are critical because an airport authority wants to buy just the right number and amount of bonds at the right time. It should be noted that highly complex projects without a clear scope are not suitable for bond funding because of the inherent risk involved (Airports Council International-North America et al. 2006) and because in this approach investor confidence is of paramount importance.

Another potential source of funds is airport cash and revenue funding; this source of funding gives airports that have consistent revenue streams the freedom to choose a delivery method without concern about outside restriction impacts such as those involved in other types of financing. Multiyear projects that need to have significant funding in place as the project commences cannot rely upon this type of funding.

Revenue-Generating Projects

Unlike other transportation projects, which have no potential for generating revenue, some airport projects have the potential for generating revenue, such as those related to concessions, parking, and real estate activities. The revenue-generating potential of projects in these areas encourages airports to try to deliver these projects as fast as is reasonably possible [Tampa International Airport, Dallas/Fort Worth International Airport]. Therefore, for these types of projects, the delivery method that can expedite the execution of the project is preferred. The risks associated with compressing a project delivery schedule are offset by the early return on investment.

Evolution of Current Alternative Delivery Methods in Airport Projects

Public procurement law has historically limited public entities to using only DBB project delivery. The current wide range of project delivery methods is a relatively recent development for publicly funded projects in the United States. The development of the public procurement laws limiting public entities to use of the DBB project delivery method can be traced in part to the Brooks Act. Enacted in 1972, the Brooks Act (Public Law 92-582) states that design services on federally funded projects in the United States should be procured on the basis of qualifications only. Alternatively, numerous laws and statutes throughout the United States have limited the procurement of constructors to the lowest responsible, responsive bidder. The combination of these two procurement practices has helped solidify the proliferation of DBB in the public sector.

DBB was the traditional project delivery method in transportation projects until 1996 when the Federal Acquisition Reform Act explicitly authorized the use of a design-build (DB) project delivery method for federal projects. While experimentation with the DB delivery method on transit projects started as early as 1994, alternative delivery methods started to be considered for airport projects only after 2000. In 2000, Congress established a pilot program for federally funded airport improvement projects that allowed the FAA to test DB contracting and other alternative delivery methods (FAA 2005, Loulakis 2003).[1] Title 49 of the United States Code was amended to

[1] The Wendell H. Ford Aviation and Investment Reform Act for the 21st century.

add Section 47142, which established DB as an acceptable delivery method under the AIP. On June 20, 2001, the FAA issued a memorandum allowing the procurement of DB contracts using either a qualifications-based selection (QBS) or a competitive proposal selection process. Subsequent to the successful experience of using DB in several projects, many states passed new legislation and codes to allow alternative project delivery methods, i.e., DB and construction manager at risk (CMR). Adding the responsibility of operation and maintenance to DB projects expanded to another delivery method called design-build-operate-maintain (DBOM). The difference among delivery methods, the unique characteristics of each project, and the variety of parameters affecting project delivery method selection have made the delivery method selection decision complicated for many airports. The purpose of this guidebook is to facilitate decision-making by clarifying the differences among the delivery methods and proposing a structured decision-making approach that incorporates all the pertinent parameters.

Definitions of the Delivery Methods

Since the early 1980s, owners of construction projects have been putting greater pressure on the architecture/engineering/construction (A/E/C) industry to improve quality, reduce cost, and, more importantly, compress the period from project conception to project completion for all kinds of public and private facilities. As a result, both construction project owners and the industry have experimented with various forms of project delivery with varying degrees of success. The adoption of alternative project delivery methods has added to the challenge of selecting the method most appropriate to the owner's needs and desires as well as to the project's technical requirements. This guidebook provides a set of standard project delivery definitions (see below and Appendix B) to help communicate the technical requirements for bringing a new project from the owner's conception to operation and finally to decommissioning.

"Project delivery method" is a term used to refer to all the contractual relations, roles, and responsibilities of the entities involved in a project. The Associated General Contractors of America (AGC) define project delivery method as "the comprehensive process of assigning the contractual responsibilities for designing and constructing a project. A delivery method identifies the primary parties taking contractual responsibility for the performance of the work" (AGC 2004). *Thus, the different project delivery methods are distinguished by the way the contracts among the owner, the designer, and the builder are formed and the technical relationships among parties within those contracts.*

The Construction Industry Institute (CII) maintains that there are really only three fundamental project delivery methods: DBB, DB, and CMR (Construction Industry Institute 1997). While there are a multitude of names for project delivery methods throughout the industry, CII is essentially correct. Therefore, this guidebook will focus its information on those three methods.

The AGC (2004) also distinguishes between the delivery method and the management method. The management method "is the mechanics by which construction is administered and supervised" (AGC 2004). This function is either retained by the owner agency or is outsourced. An example of outsourcing the management process is to hire an agency construction manager (CM) to represent the owner's interests during design and construction. Theoretically, any management method may be used with any delivery method. For example, the owner may hire an agency CM to manage a DBB, DB, or even a CMR project.

It is also important to note the distinction between a *delivery method* and a *procurement method.* A recent Transportation Research Board report breaks procurement methods down into three categories: low-bid, qualifications-based, and best-value. These are defined as follows (Bearup et al. 2007, Scott et al. 2006):

- A **low-bid** procurement method is one in which a contract is awarded on the basis of a low price alone. No other factors are considered.
- A **qualifications-based** procurement method is one in which a contract is awarded on the basis of qualifications alone. Price is not considered.
- A **best-value** procurement method is one in which a contract is awarded on a combination of price and other key factors such as qualifications, schedule, technical approach, and so forth.

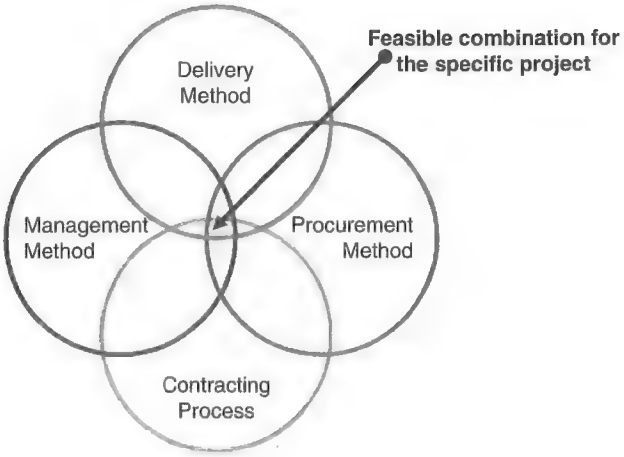
Once again, each of the delivery methods can theoretically be procured by any of the above procurement methods. It is important to factor the procurement method that will be used into the project delivery method selection decision. The issue here is to ensure that a perceived advantage of a given project delivery method is not in fact turned into a disadvantage by the procurement method used by the construction project owner.

The final issue that must be considered when selecting a project delivery method is the contracting process that will be used to get to a final award. Three possible contracting processes—one-step, two-step, and multiphase—are defined below:

- In a **one-step** contracting process, competitors are asked to submit all required information at one time. Those submissions are evaluated, and an award is made in accordance with the selected procurement methodology.
- In a **two-step** contracting process, competitors are asked to submit qualifications in the first step that are then evaluated to form a short list of qualified competitors. The second step comprises the submission and evaluation of all other required information. Again, the award is made in accordance with the selected procurement methodology.
- In a **multiphase** contracting process, the project is divided into phases and the winning competitor is selected using the qualifications-based procurement method. Upon selection, the required information is submitted and evaluated on a phase-by-phase basis until the entire project is awarded. (Note: this is an emerging process with which there has been only anecdotal experience) (Cornell 2007).

Included in each of the above contracting processes are considerations for the contract type that will be ultimately executed for the project. The literature lists four ways in which the owner can compensate the winning competitor: guaranteed maximum price (GMP), cost plus, negotiated lump sum, and lump sum (Bearup et al. 2007). Once again, the perceived advantages and disadvantages of each candidate project delivery method must be reviewed in the context of the contracting process to ensure that the potential benefits of selecting a given delivery method are not rendered unattainable by the contracting process. Figure 2-1 is conceptual representation of how the various components of project delivery interrelate.

The intent of the discussion above is not to overcomplicate the project delivery decision-making process by turning it into a four-way matrix with a multitude of permutations and combinations of possible outcomes. Airport owner/operators have standing procedures that they use to deliver capital projects, and, in most cases, they will continue to use their preferred management, procurement, and contracting processes. The purpose of the discussion is to alert the reader that the selection of a project delivery method cannot occur in a vacuum. The analysis of candidate project delivery methods must be undertaken within the context of a given delivery method, procurement method, contracting process, and management method to ensure that the result is specific both to the project and to the airport organization that will ultimately deliver the project. The remainder of this report will focus on its subject: selecting an appropriate project delivery method. It should be noted that it can be useful to retain the services of a project delivery professional to review the owner's needs and ensure that the best combination of delivery method, procurement method, and implementation procedure is chosen (Warne and Beard 2005).



(Adapted from Bearup et al. 2007.)

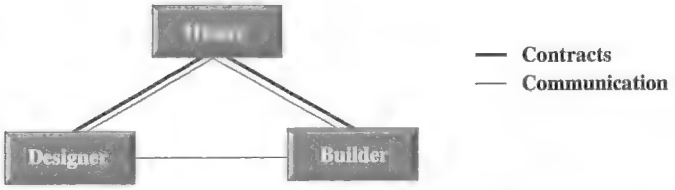
Figure 2-1. Graphic illustration of the inter-relationship of the components of project delivery.

Descriptions of project delivery methods (DBB, CMR-CM/GC, and DB) are given below. To assist the reader in putting the contents of this report into proper context, each project delivery method description includes a graphic displaying contractual relationships. Note that the lines of communication shown in the graphics represent the ability to exchange information through formal and informal requests among the various entities in the project.

DBB

DBB is the traditional project delivery method. In this method, a project owner retains a designer to furnish complete design services and then advertises and awards a separate construction contract that is based on the designer's completed construction documents. The owner is responsible for the details of design and warrants the quality of the construction design documents to the construction contractor.

Figure 2-2 shows the basic relationships among project participants in a DBB delivery system. The owner "owns" the details of design during construction and, as a result, is financially liable for the cost of any design errors or omissions encountered in construction. This principle is called the "Spearin Doctrine" (Mitchell 1999). The construction phase of DBB projects is generally awarded on a low-bid basis. There is no incentive for the builder to minimize the cost of change orders in this delivery method. In fact, there can be quite the opposite effect. A builder who has won a project by submitting the lowest bid may need to look to post-award changes as a means of enhancing profit on the project. One author states that the defining characteristics of DBB are as follows (Bearup et al. 2007):



(Adapted from American Institute of Architects, California Council 1996.)

Figure 2-2. Design-bid-build.

- There are separate contracts for design and construction,
- Contractor selection is based entirely on cost, and
- Design documents are 100% complete.

DBB projects can also be awarded on a negotiated basis and a best-value basis (Scott et al. 2006). In both cases, the probability that the project will be awarded to a builder who has submitted a mistakenly low bid is reduced. Additionally, in both cases, the builder will be motivated to complete the project in such a way that it will be invited back to do the next negotiated contract or that will reflect well in the next best-value selection. Regardless of the procurement method, DBB involves less builder input to the design than DB or CMR. Thus, the owner must rely on the designer or agency CM (and not the builder) for a constructability review, if there is any at all. Nonetheless, in this method the owner has full control over the details of design, which may be a requirement for some complex projects.

DBB is also characterized by the greatest amount of competition in both the design and construction areas. All qualified designers can compete for the design without restriction. Additionally, all constructors who can furnish the requisite bonding can compete without constraint. Design subconsultants and construction trade subcontractors can also compete with minimal restriction. Finally, as DBB is normally viewed as the traditional project delivery method in the United States, it is well understood and well accepted by owners and members of the design and construction industries.

CMR or CM/GC

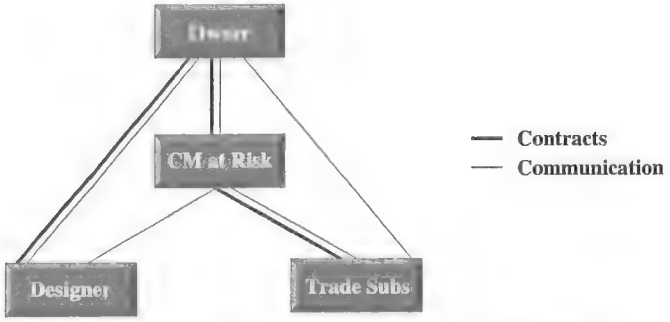
CMR projects are characterized by a contract between an owner and a CM who will be at risk for the final cost and time of construction. In this agreement, the owner authorizes the construction manager to handle the details of a project's lifecycle. The idea of CMR is to furnish professional management of all phases of a project's life to an owner whose organization may not have those capabilities. These projects normally use the qualifications-based procurement method to select the CMR. It is possible to apply best-value procurement with the CMR's qualifications and proposed fees being taken together to form the best-value metric.

Typically, CMR contracts contain a provision in which the CMR stipulates a GMP above which the owner is not liable for payment. Often these contracts include incentive clauses in which the CMR and owner can share any cost savings realized below the GMP. Some states, like Oklahoma, take the GMP and convert it to a firm fixed-price contract and administer the construction as if it were a traditional DBB project thereafter (American Institute of Architects 2005). CMR contracts can contain provisions for the CMR to handle some aspects of design, but generally the owner retains the traditional responsibility by having a separate design contract and furnishing the CMR with a full set of plans and specifications upon which all construction subcontracts are based (see Figure 2-3). The CMR will usually be paid for furnishing preconstruction services such as cost engineering, constructability review, and development of subcontractor bid packages. According to AGC (2004) the defining characteristics of the CMR are the following:

- The designer and the CMR hold separate contracts with the owner and
- The CMR is chosen based on criteria other than just the lowest construction cost, such as qualifications and past performance.

According to Bearup et al. (2007), additional defining characteristics are the following:

- The CMR contracts directly with trades and takes on "performance risk" (cost and schedule commitments),
- The schedule allows for overlapping design and construction,



(Adapted from American Institute of Architects, California Council 1996.)

Figure 2-3. Construction manager at risk.

- The owner procures preconstruction services from the CMR, and
- The owner expects the CMR to provide GMP and to commit to a delivery schedule.

A final defining characteristic, noted in the American Institute of Architect's (AIA's) "Construction Manager at-Risk State Statute Compendium," is that "transparency is enhanced, because all costs and fees are in the open, which diminishes adversarial relationships between components working on the project, while at the same time eliminating bid shopping" (American Institute of Architects 2005, p. 1).

Constructability and speed of implementation are the major reasons an owner would select the CMR method (3D/International, Inc., undated). Additionally, CMR greatly facilitates phased construction if that is a requirement for given project. Unlike DBB, CMR brings the builder into the design process at a stage in which definitive input can have a positive impact on the project: "The CM[R] becomes a collaborative member of the project team. Preconstruction services include budgeting, cost estimating, scheduling, constructability reviews and value engineering studies" (3D/International, Inc., undated, p. 4). In CMR, the CM essentially becomes the GC at the time the GMP is established. While some experts attempt to distinguish between CMR and CM/GC, due to perceived levels of risk, many agencies use these terms more or less interchangeably.[2] The CMR can and is expected to provide realistic project cost estimates early in the project lifecycle. It is anticipated that after a certain amount of the design is complete and the project is sufficiently defined, the owner will enter into a contract with the CMR for providing construction services. Many states reserve the right to go out for bids if they think that the CMR's price is not competitive (Minchin et al. 2007).[3]

As the design selection process in CMR virtually mirrors the design selection process in DBB, implementing CMR does not inherently restrict competition among designers and design subconsultants (American Institute of Architects 2005). Owners occasionally require the designer in a CMR project to have previous CMR experience, which will impose a constraint on competition. Also, as the constructor is selected on a basis of qualifications and past performance and must have the capability to perform preconstruction services, CMR project delivery can constrain competition to those constructors that have previous CMR experience. Most public CMR laws require

[2] According to AGC (2004), there has been some confusion about the terms CMR and CM/GC because of the assumption that the phrase "at risk" connotes cost guarantee. Even if there are no cost guarantees, the CM is still at risk because the CMR holds the trade contracts (warranting the performance of the work). Because of this, some users choose to avoid the debate over the term "at risk" and instead use the term CM/GC (p. 8).

[3] There are two types of CM arrangements, namely agency CM and CMR. The emphasis in this work is CMR. Agency CM is not a project delivery method because the CM is not contractually responsible for delivering the project. The role of agency CM is purely advisory, and, thus, the agency CM is usually not at risk for the cost and schedule of building the project.

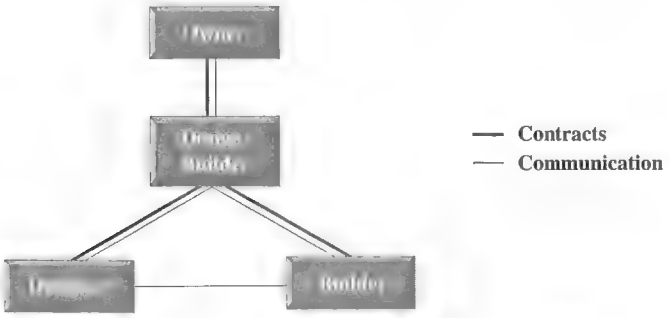
competitively bidding out the construction trade subcontract work packages. The central idea of CMR is to get the advantage of price competition in the subcontract work packages combined with the QBS of the GC as CMR.

DB

DB is a project delivery method in which the owner procures design and construction services in the same contract from a single, legal entity referred to as the design-builder. A variety of approaches exist for selecting the design-builder. The most common contracting processes are the one-step and the two-step processes. The one-step process provides for competitive evaluation of technical proposals, with the contract award decision based on best value to the owner agency. The determination of best value is based on a combination of technical merit and price (Molenaar et al. 1999). The two-step process separates the technical proposal from the price. The method typically uses request-for-qualifications (RFQ)/request-for-proposal (RFP) procedures rather than the DBB invitation-for-bid procedures. There are a number of variations on the DB process, but all involve three major components. First, the owner develops an RFQ/RFP that describes essential project requirements in performance terms. Second, proposals are evaluated. Finally, with evaluation complete, the owner must engage in some process that leads to contract award for both design and construction services. The DB entity is liable for all design and construction costs and usually provides a firm, fixed price in its proposal (El Wardani et al. 2006, Ibbs et al. 2003, Graham 1997).

DB projects can and have been delivered using all three procurement methods. Experience in the highway industry with low-bid procurement for DB projects has been less than satisfactory, and the *AASHTO Guide for Design-Build Procurement* specifically recommends against it (AASHTO 2008). The reference recommends the use of two-step, best-value procurement as the preferred method for highway transportation projects. Qualifications-based procurement can also be used on DB projects and allows the owner to bring the design-builder on board at an early stage to assist in project development activities. Indeed, the survey of nine U.S. airports by the research team showed that several had used the qualifications-based procurement process. The qualifications-based procurement process is combined with a negotiated GMP contracting process, which may also use the multiphase process. This combination has been referred to as "DB progressive GMP." Its aim is to reduce the contingency for scope creep during the design phase that is typically contained in a lump-sum DB price proposal by not forcing the design-builder to commit to a price until the details of the design are reasonably stable.

Figure 2-4 shows that from the owner's standpoint, DB simplifies considerably the project's chain of responsibility. As in CMR, the builder has early constructability input to the design



(Adapted from American Institute of Architects, California Council 1996.)

Figure 2-4. Design-build.

process. As the owner no longer owns the details of design, the owner's relationship with the design-builder must be based on a strong degree of mutual professional trust (Beard et al. 2001). The design-builder literally controls this project delivery method. As a result, the DB project delivery method has proven to be highly successful in compressing the project delivery schedule and is therefore often used for "fast-track" projects.

Bearup et al. (2007) state that the defining characteristics of DB are as follows:

- A single point of responsibility,
- A schedule that allows for overlapping design and construction,
- A design-builder that furnishes preconstruction services during design, and
- An owner that expects the design-builder to provide a firm, fixed price and to commit to a delivery schedule.

DB creates the greatest constraint on competition in that all parties to the DB contract are selected using qualifications and past performance as major selection factors. Because the owner transfers responsibility for all design and construction in the DB contract, the owner loses the ability to foster competition between design subconsultants and construction trade subcontractors. There is typically no requirement to competitively bid for subcontract work packages, and often the scale, complexity, and speed at which DB projects are executed precludes firms with no DB experience from being able to participate. Additionally, because the contract is awarded before the design is complete, DB can also create an unfavorable risk environment for subcontractors whose cost-estimating systems lack the sophistication to price work without competed construction documents.

There are many variations on the DB method. Design-build-operate-transfer, design-build-operate-own (sometimes called lease-back), and design-build-operate-maintain (DBOM) all require the DB contractor to remain with the project after construction is complete. DBOM is very similar to DB except that the contractor assumes the operation and maintenance risks and is responsible for operating the new facility according to a set of regulations and codes for a determined duration (Wiss et al. 2000, Kessler 2005).

Legality of Delivery Methods in Various States

DBB has traditionally been used throughout the United States, and all state codes give authority to airports to use it in their projects. Alternative delivery methods do not have this clear statutory support. Some states do not allow airport entities to use them while other states have permitted one-time use of an alternative delivery method for a special project. Still another group of states have put some limits on the application of alternative delivery systems. For example, according to a current statute for airport projects in Massachusetts, the use of DB is restricted to horizontal projects that are $5 million and larger, and CMR is applicable only to vertical projects that are $10 million and larger [Logan International Airport]. Developing pilot programs is a common approach in some states for implementing previously unauthorized project delivery methods, particularly DB. In order to update information on the legal status of alternative project delivery methods in various states, a thorough literature search needs to be conducted on the laws of all 50 states, which is beyond the scope of this work. Also, due to frequent changes in the regulations, the authors of this research believe that each airport is in the best position to assess the legality of a certain delivery method locally.

According to federal laws, the FAA plays a minimal role in the procurement process used for airport projects that are supported by the AIP. For instance, under 49 CFR §18.36, states that are sponsors of airport projects are authorized to conduct procurement in the same way (complying with

the same laws and using the same procurement systems) that they do for projects not funded in part or whole by the federal government. Likewise, non-state airport sponsors (e.g., cities) may use their own procurement systems as long as they comply with state and local laws and regulations and conform to 49 CFR §18.36 and other applicable federal laws. Requirements for third-party contracting, described in FAA Order 5100.38C (*The Airport Improvement Program* [*AIP*] *Handbook*) (FAA 2005), are sufficiently flexible to allow airport sponsors to select their contractors through competitive bidding and/or competitive proposal/RFP (both price and other parameters considered). For DBB, FAA Order 5100.38C (*The Airport Improvement Program* [*AIP*] *Handbook*) (FAA 2005) allows the procurement of services through sealed bidding or competitive negotiations. For DB, the grantees must procure DB services through QBS or competitive proposal selection procedures. It therefore appears that if a specific state or city allows an alternative project delivery method, federal regulations do not prevent an airport from deciding to use one.

Existing Selection Approaches for Project Delivery Methods

Selection of the appropriate alternative project delivery method is a complex decision-making process. The decision should be made as early in the design phase as possible; preferably in the project scoping process and certainly before the final construction estimates for the project are ready. The decision will be made when the owner still has little information about the outcome of the project and the project plans are not detailed enough to be reliable grounds for judgment about the project. In this situation, having a framework for decision-making is vital for airport projects. This framework should be simple, comprehensive, rational, and objective. The literature reviewed for this research shows that some experts have concentrated on this issue and have developed a list of criteria and some decision-making frameworks (Airports Council International-North America et al. 2006, Debella and Ries 2006, Garvin 2003, Gordon 1994, Ibbs et al. 2003, Konchar and Sanvido 1998, Mahdi and Alreshaid 2005, Oyetunji and Anderson 2006). Several of these researchers have studied a few projects and have based their selection methodology on the characteristics of those projects.

The relevant literature can be divided into two groups: (1) literature that compares the project delivery methods on the basis of the observed performance measurements collected from a group of projects and (2) literature that provides a list of criteria and a framework for decision-making. One of the best examples of the first group is an article by Konchar and Sanvido (1998) in which a set of criteria is defined for a performance comparison of different delivery methods (i.e., DB, DBB, and CMR) in 351 building projects. These criteria are mostly objective and measurable, such as cost growth, construction speed, and schedule growth. Some criteria are also defined to incorporate the quality performance of the delivery methods, such as difficulty of facility start-up, number and magnitude of call backs, and operation and maintenance costs. According to Konchar and Sanvido (1998), "when all other variables were held constant, the effects of project delivery method indicated design/build projects to be at least 5.2% less than design/bid/build projects and 12.6% less than construction management at risk projects on average in terms of cost growth." In their study, Konchar and Sanvido (1998) divided the projects into six different groups (such as light industrial, complex office, heavy industrial, and so forth) in order to get clearer trends in each group. Because Konchar and Sanvido's study (1998) did not specifically mention airports, it is important to be careful in using this data to draw conclusions about the performance of different delivery methods in airport projects.

Two studies of DB versus DBB project performance in the federal building sector did make direct comparisons (Allen et al. 2002, Gransberg et al. 2003). One study compared 54 DBB projects with 34 DB projects and discovered that DB projects had 16.4% less cost growth and 19.0%

less time growth than similar DBB projects (Gransberg et al. 2003). Another study, which looked at 110 Navy projects, also found that DB projects performed more efficiently, with 18.0% less cost growth and 60.0% less time growth (Allen et al. 2002). Additionally, *NCHRP Report 561: Best-Value Procurement Methods for Highway Construction Projects* furnished a direct comparison of transportation project performance that took into account delivery methods (Scott et al. 2006). While this study did not include CMR projects, it included DBB projects awarded on a best-value basis, which parallels the CMR delivery method. The NCHRP study found that DB projects had 4.7% less cost growth and 9.3% less time growth than DBB. Best-value projects had 2.0% less cost growth and 18.5% less time growth than DBB. Other researchers, such as Debella and Ries (2006) and Ibbs et al. (2003) have used a methodology similar to that of Konchar and Sanvido (1998), but they have narrowed down the scope of their research either to special kinds of projects or fewer performance measures.

The second kind of literature mentioned above, literature that provides a list of criteria and a framework for decision-making, has focused on the decision-making process. This literature proposes mechanisms for decision-making and defines the necessary criteria and frameworks so that the most important project parameters are identified and used in the decision-making process. The frameworks are primarily intended to be simple, rational, and comprehensive. They range from basic flowchart methods (Airports Council International-North America et al. 2006, Gordon 1994) to more sophisticated processes based on methodologies such as multiple linear regression, the Analytical Hierarchy Process (AHP) (Mahdi and Alreshaid 2005), or the Simple Multi-Attribute Rating Technique with Swing Weights (SMARTS) (Oyetunji and Anderson 2006).

Airports Council International-North America (ACI-NA) in an effort with the Airport Consultants Council (ACC) and the Associated General Contractors of America (AGC) developed a white paper in 2006 that offers basic guidelines for selecting the most appropriate delivery method for airport projects. The guidelines comprise a list of factors that owners should consider in relation to each delivery method (Airports Council International-North America et al. 2006). Gordon (1994) created a procurement method selection model that uses a flowchart for selecting the best contracting method. Within the flowchart are a number of drivers that direct the owner's attention to the most important issues in project delivery method selection. A/E/C Training Technologies (Loulakis 2005) has developed a multimedia education compact disc and delivery selection tool. The tool integrates training on project delivery selection systems with a matrix-style decision framework that owners can complete to make an informed delivery selection. Skitmore and Marsden (1988) presented a multi-attribute analysis technique and a discriminant method for selecting delivery methods. The multi-attribute method uses utility factors to evaluate the suitability of a delivery method with respect to a client's priority criteria. Kumaraswamy and Dissanayaka (1996) propose a client advisory system with an expert system front end that will gather project information and model the project profile to generate a list of delivery options. Finally, Oyetunji and Anderson (2006) use a SMARTS approach for delivery selection. The approach utilizes a matrix that has 20 criteria, each with a given weight. The owner rates these criteria and goes through the required calculation, which gives a single rank to each delivery method. The delivery method with the highest rank is the one that should be chosen for the project.

Looking at both kinds of literature, one finds that many of the important parameters that affect project delivery decisions early in the process fall into one of four groups: project-related parameters, agency-related parameters, legal parameters, and lifecycle issues. Project-related parameters are those parameters that pertain to project duration: estimated cost, quality level, project risks, limits on schedule growth, project complexity, and so forth. Agency-related parameters mainly consist of the legal status of the agency, the role of a project in the objectives and plans of the agency, the availability of funds, the level of experience and competence of the agency's staff, flexibility needs in the construction phase, the level of risk assumption, the importance of preconstruction

Table 2-1. The timing of project delivery method selection.

Project delivery method	At the end of conceptual design	At the end of preliminary engineering	At the end of final design	Construction
DBB	■	■	□	◦
CMR	■	□	□	◦
DB / DBOM	■	□	◦	◦

■ Desirable
□ Feasible
◦ Not feasible

services, and the level of quality expected. The legal parameters mainly cover legal and contracting issues, such as statutory authority to use alternative project delivery methods and the permits needed for the project. Lifecycle issues cover the costs of maintaining and decommissioning the facility as well as the ability to minimize energy usage and any negative environmental effects of the project. One emerging requirement is sustainable design and construction, which is directly tied to project lifecycle issues.

In the parameters mentioned above, the ability to transfer the risks of a project to entities other than the owner is a characteristic that is related to both the project and the owner agency. This parameter involves the level of risk and uncertainty of the project and also the ability of the owner to assume the risks or transfer them (risk-prone or risk-averse agency). Different project delivery methods provide different mechanisms for risk distribution among the entities involved. In summary, the existing body of knowledge in this area, along with specific information collected during the interviews for this research, provide a solid foundation for developing a new selection system that is tailored to the needs of airport owners and operators.

Timing of Project Delivery Method Selection

As a project moves through various stages of development, the window of opportunity to select some project delivery methods will close. Therefore, it is important to try and make this decision as early as possible. For instance, Logan International Airport decided on a delivery method before the design stage of its project. Tampa International Airport hired a DB contractor based on QBS at the beginning of project design and then a design-builder took the design to 60% complete while cooperating with airport staff. In most airports, the default delivery method is DBB; however, based on factors such as schedule compression, cost control, type of funding, control of design, and so forth, some airports may consider an alternative delivery method [Norman Y. Mineta San Jose International Airport, Hartsfield-Jackson Atlanta International Airport].

Table 2-1 maps project delivery method selection with project development phase. Project development has been broken into four phases: conceptual design (including the scoping), preliminary engineering, final design, and construction. Table 2.1 shows that it is desirable to select a project delivery method relatively early in the project development process. Most of the benefits can be realized by engaging the constructor as soon as possible. The decision point for project delivery method selection should not be confused with the time that the constructor is engaged. As an example, an owner may decide to engage a DB contractor at the end of preliminary engineering or even later in the process in order to clarify the project scope and reduce uncertainty. However, the owner should have decided on the project delivery method (e.g., DB) much earlier, so that the design documents could be developed to properly accommodate the type of delivery method.

CHAPTER 3

Advantages and Disadvantages of Each Project Delivery Method

Introduction

There are numerous issues that airports need to consider when selecting a project delivery method. In this chapter, the information collected during this research on pertinent issues is synthesized for use in Tier 1 and Tier 2 of the selection system presented later in the guidebook. These pertinent issues and their interactions with different project delivery methods are presented in this chapter in the format of a descriptive pro-con analysis. The issues were identified through a literature search, past project delivery research experience, case studies, and interviews with airport authorities during this effort. These issues are organized into the following categories:

- Project-level issues,
- Airport-level issues,
- Public policy/regulatory issues, and
- Other issues.

Table 3-1 provides a list of these pertinent issues. In this chapter, each pertinent issue is first defined and then the advantages and disadvantages of each delivery method in dealing with that particular issue are explained. The analysis is based on the trends found in the interviews and is supported by citations from relevant literature. A list of the references used is provided in Appendix A. A brief summary is provided at the end of each section that combines the results of the interviews and the literature search.

Readers should note that analysis of the pertinent issues in relation to the various project delivery methods is complex. The results presented in this chapter represent trends and, in some cases, national averages for each of the pertinent issues. Each project and each owner are unique. The interaction of a given project delivery method with a given issue may in general be advantageous (or disadvantageous); however, for a specific project this may not be the case. The result of the analysis therefore represents the majority of projects, but not all of them. Furthermore, for the DB project delivery method, the effect of the chosen procurement system (best-value selection or QBS) is described for each pertinent issue if the procurement system has an effect on the project delivery selection decision in the context of that pertinent issue.

Project-Level Issues

Project-level issues are those that are specific to the project under consideration and include such items as project size/complexity, schedule, cost, risk management/allocation, lifecycle, and maintainability.

Table 3-1. Pertinent issues for airport projects.

Project-level Issues
1. Project size/complexity
2. Schedule compression
3. Schedule growth control
4. Early cost precision
5. Cost control
6. Risk management/allocation
7. Lifecycle costs
8. Maintainability
Airport-level Issues
9. Airport experience/staff capability
10. Airport control of project
11. Security
12. Control of impact on passengers and operations
13. Third-party stakeholder input to design and construction
Public Policy/Regulatory Issues
14. Competition and local talent
15. DBE/small business impacts
16. Legal and statutory constraints
17. Sustainability and LEED certification
Other Issues
18. Adversarial relationships
19. Construction claims

Issue 1: Project Size/Complexity

This issue reflects both the dollar value and complexity of an airport project based on the type of project. Paving projects, while large in dollar value, can be less complex than systems upgrades for luggage-handling operations. There is a wide variety among airport projects, which include both horizontal and vertical projects that can range in cost from a few thousand dollars to hundreds of millions of dollars. For instance, over the past 5 years, Logan International Airport's projects have ranged in cost from $10,000 to $165 million.

Airport projects are sometimes larger than $100 million in value (e.g., terminals); however, airports most often undertake smaller projects, such as the construction of parking garages or the renovation of building facilities. Through studying project size and complexity, airports seek to determine which delivery method is suitable for a project with a given size and complexity and how changing the size may impact the choice of delivery method.

DBB

DBB has been used successfully on projects of all sizes. However, as projects grow in size and complexity, airport oversight of DBB can become burdensome. Two of the interviewed airports indicated that they tend to select DBB for smaller sized projects (less than $10 million) [Logan International Airport, Hartsfield-Jackson Atlanta International Airport]. At least two airports have been hesitant to use DBB for large and complex projects [Tampa International Airport, Hartsfield-Jackson Atlanta International Airport].

CMR

This delivery method seems to be more suitable for large projects and projects with complex managerial requirements. This aspect of CMR is due to the increased focus on project management that is realized through CMR's preconstruction services, which result in added value to the project (Barnstable Municipal Airport 2007, Kuhn 2007) [Hartsfield-Jackson Atlanta International Airport]. Some airports have restrictions on the size of projects with which CMR can be

used; for example, Logan International Airport applies this method to vertical projects larger than $10 million.

DB

This delivery method is usually selected for large and complex projects (Florkowski 2007b). Some airports use DB only in projects that exceed a certain dollar value [Norman Y. Mineta San Jose International Airport]. As an example, DB projects in Logan International Airport must be horizontal and larger than $5 million. Large and complex projects can benefit from the use of QBS with a negotiated price if the airport has experience in negotiating prices on large projects. Best-value procurement shifts more risk for a fixed price onto the design-builder on large/complex projects; however, airports have successfully procured design and construction projects using this procurement method. One of the airports interviewed has used low-bid DB on three relatively simple green-field building projects. It should be noted however, that the use of low-bid DB is not indicated in most circumstances and will not be considered explicitly in this guidebook.

Issue 2: Schedule Compression

From the owner's viewpoint, each delivery method affects project schedule in two different ways: (1) schedule shortening and (2) schedule growth control. The effect of project delivery method on schedule compression will be discussed here. The effect of project delivery method on schedule growth control will be discussed in the next section.

DBB

DBB uses a sequential process that makes significant schedule compression difficult. This sequential process results in a schedule that is longer than the schedules of the two alternative delivery methods due to the need to complete project designs prior to the award of the construction contract. (Gordon 1994, Walewski et al. 2001). Analysis of the airport interviews shows that the inability to compress the schedule and control time growth (due to delays caused by design errors) in DBB has been one of the main reasons that owners choose other delivery methods. One way of compressing DBB projects is to break a project down into several phases/packages and award each package separately. However, coordinating the efforts of multiple contractors can be problematic; the possibility that abutting primes will interfere with each other's work is increased and because of this so is the risk of delay claims.

CMR

It has been shown that CMR has the ability to meet or exceed schedule requirements (Minchin et al. 2007). CMR also has been successfully used to deliver airport projects (e.g., Fairbanks International Airport) that must be phased due to operational reasons (Storm 2007). This delivery method can also help owners with projects that are schedule sensitive (Walewski et al. 2001) and can save time during the project because of concurrent design and construction (Oregon Public Contracting Coalition 2000), but some airports have not found this time savings to be a distinguishing advantage for CMR and do not believe that it can save considerable project time [Logan International Airport].

DB

Schedule flexibility increases in this delivery method because designer and builder are one entity (Oregon Public Contracting Coalition 2002). Many experts believe that DB results in faster project delivery (Gransberg and Molenaar 2007, Konchar and Sanvido 1998, Molenaar and Scott 2003, Walewski et al. 2001) and has the least schedule growth (Konchar and Sanvido 1998, Scott et al. 2006). All nine airports interviewed for this research cited this issue as the most important

reason for choosing DB. Schedule compression will not be significantly affected by the design-build procurement process.

Issue 3: Schedule Growth Control

This section discusses the effect of project delivery method on controlling and preventing time growth in a project. Schedule growth and project delays have been major problems in construction activities. For example, according to a recent survey (FMI/CMAA Undated), 40 to 50% of all construction phases experience schedule growth.

DBB

DBB schedule growth tends to be higher than the schedule growth of other project delivery methods. According to *NCHRP Report 561: Best-Value Procurement Methods for Highway Construction Projects,* DBB projects had the greatest average time growth (Scott et al. 2006). Due to the owner's liability for delays resulting from design errors and the fact that differing site conditions will be found after construction award, the owner has limited ability to control project time growth and very little ability to recover the schedule if a delay is realized with DBB. Dallas/Fort Worth International Airport uses DBB when it has no need for speed.

CMR

Early involvement of the constructor helps the project team develop a more practical and realistic schedule for the project if construction managers with significant construction experience are selected. Analysis of the interviews with airports shows that this delivery method has the best performance in developing an accurate preconstruction schedule and achieving it. Dallas/Fort Worth International Airport uses CMR when it feels a need for speed.

DB

Many experts believe that DB has the least schedule growth (Konchar and Sanvido 1998, Scott et al. 2006). Another effect of DB is earlier schedule certainty (AASHTO 2008) because the design-builder submits the project schedule at the time of contract award, before the design is complete. Another important characteristic of DB for airports is that it obligates design and construction funds before the end of a given fiscal year if a project is awarded through a best-value, fixed-price option (Gransberg and Molenaar 2007). This can help airports award the project and allocate available funds to a project without waiting for its design to be complete. Dallas/Fort Worth International Airport uses DB when it believes speed is of the utmost importance. With the exception of obligating funds, schedule growth will not be significantly affected by the DB procurement process.

Issue 4: Early Cost Precision

Early and precise project cost estimation is always sought by airports. This section discusses the effect of each project delivery method on the ability to accurately estimate costs.

DBB

Basing the engineer's cost estimate on a complete design before advertising the project increases the certainty of cost estimates. Additionally, after bids have been received, the owner learns the value of the project's scope in the context of current market conditions. The owner also has the opportunity to cancel the project or alter the design and scope, losing only part of the design cost if the bids exceed its budget. The level of cost certainty increases even more when the payment method is lump sum.

CMR

This delivery method has two main characteristics relevant to project cost: (1) it is usually combined with a GMP payment mechanism and (2) the constructor is involved in the project's design phase prior to bidding subcontractor work packages. These two characteristics tend to improve cost accuracy in this delivery method. Usually, the owner can negotiate and set the GMP at about 60% design completion (AGC 2004). If the project involves the services of major trades or specialty subcontractors, they can be brought on board during the design phase to furnish technical input to the design. This way, the project team can benefit from their knowledge and experience and establish a more reliable early budget. The drawback is the loss of the opportunity to seek competitive bids on these packages. Some airports are prohibited by law from hiring subcontractors without going to public bidding. Using CMR, the owner will know the estimated cost earlier in the project lifecycle than it would using DBB [Logan International Airport], but it is somewhat difficult to evaluate the validity of the GMP compared with a traditional bid process. The risk is that in some cases it becomes difficult to agree on a GMP with the CMR. Failure to negotiate the GMP in a timely manner may affect the project schedule and increase the project costs. However, the owner always has the option to cancel the CMR contract, pay the CMR for its preconstruction services, and put the construction project out for bids with the completed design [Dallas/Fort Worth International Airport].

DB

DB can be procured though both a best-value, firm fixed price or a QBS negotiated price. When design-builders provide a firm fixed price, the airport can establish a firm cost earlier in the process than it can with the other delivery methods (Gransberg and Molenaar 2007, Walewski et al 2001). The *AASHTO Guide for Design-Build Procurement* states that DB gives earlier cost certainty and has less cost growth compared with traditional DBB based on the fact that highway agencies use firm fixed-price procurements (AASHTO 2008). When using QBS, the airport's ability to achieve early cost precision is similar to that of CMR. The owner does have one additional advantage with QBS in DB in that the design-builder is liable for designing to cost at a higher standard of care than an engineer in a CMR project delivery approach who has no less knowledge of the costs of the work that they design. In both cases, the major risk revolves around the owner's ability to precisely define the scope of DB work before awarding the DB contract (Beard et al. 2001).

Issue 5: Cost Control

Cost control is a project success criterion and can drive owners to select a particular project delivery method according to its ability to (1) reduce total project costs and (2) minimize project cost overruns.

DBB

The owner of a DBB project has a determined cost estimate based on a complete set of designs, but potential change orders and errors in design may cause considerable cost overruns. The literature shows that although this delivery method has the best performance in accuracy of quantities and design calculations, its ability to achieve post-award budget is the poorest among the delivery methods (Konchar and Sanvido 1998, Scott et al. 2006).

CMR

This delivery method helps the owner control project costs because of two main characteristics: (1) it is normally awarded with a GMP payment mechanism and (2) the constructor is involved in the project design phase, furnishing real-time cost information to assist the designer with keeping to the budget. These two characteristics directly affect the performance of this project delivery method with regard to project cost control. One advantage is that there may be cost

savings because of early constructor input to the project (Oregon Public Contracting Coalition 2000) and also competitive pricing through "open book" contingency accounts (Irwin 2003). Usually, the owner can negotiate and set the GMP at about 60% design completion (AGC 2004), although the GMP can be set at other times depending on the nature of project, the amount of detail available about the design, and the owner's desire to know the cost as early as possible (National Association of State Facilities Administrators [NASFA] and AGC 2007). Phasing the design to permit the CMR to bid out design packages containing materials with volatile prices such as asphalt or structural steel allows the CMR to reduce inflation risk as well as compress the schedule for fabrication and delivery. Five out of nine of the airports interviewed for this research indicated that this delivery method is often selected for projects with budget constraints. Although this project delivery method helps the owner achieve post-award budgets, close cost monitoring on the project is highly recommended due to the manner in which the GMP is established (Walewski et al. 2001). Finally, it is possible to create an incentive to control cost by including a shared savings below the GMP clause in the contract (Kuhn 2007).

DB

Incomplete design documents at the time of award may result in costly scope changes during the construction phase [Tampa International Airport]. A TCRP study of major transit projects shows that there were fewer cost overruns with DB than with other delivery methods (Harrington-Hughes 2002). Another study shows that DB outperforms CMR in operations and maintenance costs, unit cost, and cost growth (Konchar and Sanvido 1998). The *AASHTO Guide for Design-Build Procurement* states that DB gives earlier cost certainty and has less cost growth than traditional DBB (AASHTO 2008). DB also has relatively good performance when there is budget restriction (Gordon & Rees LLP 2005) because it reduces the potential of cost overruns due to claims and delays (Beard et al. 2001).

Issue 6: Risk Management/Allocation

Each project has some level of uncertainty during various phases of its development. Methods to cope with these uncertainties are inherent in each delivery method. Research in the area of risk management has indicated that the most effective approach in risk allocation is to assign project risks to the parties in the best position to manage them. This means that the party assuming a certain risk should be the party who has the most control over that risk and is most likely to survive the negative impact of that risk (Touran et al. 1994, Allen and Touran 2005). The main vehicle for risk allocation is the contract. Thus, the project delivery method will have a profound impact on risk allocation. The effect of each project delivery method on other aspects of risk management like risk identification, quantification, and mitigation is different; therefore, selection of a delivery method is dependent upon the owner's risk management approach. These differences are considered in this section. It should be noted that the effect of risks is prevalent in many of the issues discussed in this chapter and is not limited to this section. It should also be noted that the concise format of this discussion does not allow for an in-depth treatment of risk management and risk allocation.

DBB

This delivery method has a long history in terms of statutory laws and standard contracts that entail developed risk management processes. This delivery method can help the owner divide risks between the designer and the constructor, but the risk of additional construction costs resulting from erroneous design remains with the owner (AGC 2004). When the project scope is clearly definable, the owner of an airport can follow the traditional methods of managing risks in DBB (Gordon 1994). Although risks and rewards are easy to understand in this method, disputes often arise over authority, responsibility, and quality (Walewski et al. 2001). In other words, the usefulness of having separate contracts for design and construction in helping the owner manage the risks of an airport project depends upon the proficiency and experience of the owner and its consultants in risk man-

agement. For example, one airport [Tampa International Airport] recommended not using DBB in a complex project because DBB does not facilitate the owner's need to manage project risks.

DBB can help in risk allocation through the use of unit price bids as the payment method when the project line items and their cost estimates are known, but the quantities are not known with certainty [Hartsfield-Jackson Atlanta International Airport]. This payment method allows the constructor to bid on unit prices rather than the total price. In this way, the constructor does not have the risk of fluctuating quantities while the owner will not have to pay for constructor's contingencies included in the bid because of quantity uncertainties.

CMR

CMR can aid in appropriate risk allocation between the airport and the constructor because the CM is hired before a price is negotiated. The "risk" in the term "Construction manager at risk" stems from the CM holding the trade subcontracts and taking the performance risk of the project (AGC 2004). The risk of design errors and omissions is similar to DBB because the owner holds separate contracts with the designer and CMR. The use of a GMP structure can create a mechanism to share cost risk between the constructor and the airport in the hope of ultimately reducing costs. Although GMP as a means of risk allocation should decrease the owner's risks, there is always a possibility that the owner and the CMR will not be able to consummate an agreement on the GMP in a timely fashion (for example, the CMR asks for more contingency than the owner feels is reasonable [Dallas/Fort Worth International Airport]). The owner in this case would need to terminate the CMR contract and convert it to a DBB project, potentially suffering from the resulting delay in advertising and awarding the construction project and possibly getting bids that are higher than expected.

Early constructor involvement may result in a better definition and understanding of the project risks, allowing a more efficient risk allocation to be achieved [Logan International Airport]. This delivery method is conducive to teamwork. The constructor shares information with the owner and designer on trade subcontracts, value engineering, and so forth. This is one reason some experts believe that CMR theoretically reduces the risks of every entity involved in the project (Minchin et al. 2007). Although CMR facilitates risk management, it is not necessarily the best method for risk allocation. Having an experienced constructor on board improves the whole process of risk management, including risk allocation, but the increase in the number of parties directly involved in the project and some overlaps among their duties may make the risk allocation more difficult (Touran et al. 2009).

DB

Risk allocation and risk management are inherently different in DB delivery than they are in DBB and CMR delivery. The risk for errors and omissions in the design is transferred from the owner to the DB contractor. Having single point accountability for design and construction removes the owner from designer-versus-constructor disputes over responsibility for changes in cost or time of project execution (Harrington-Hughes 2002, Irwin 2003, Riley et al. 2005). From the owner's perspective, the DB approach reduces the size and frequency of change orders (Molenaar and Scott 2003, Riley et al. 2005). Agencies should realize that although the risks are contractually transferred to the design-builder, a poorly defined initial scope in the RFP may result in significant cost increases. Also, it is not wise to allocate all risk to the DB contractor because that drastically increases the contingency and constructor's insurance costs, which will be transferred to the owner through the bid (AGC 2004). As the design-builder's scope of work includes project design, the design-builder may be required to carry errors and omissions insurance (which is usually required from design firms) in this transfer of risks (AGC 2004, Irwin 2003). In essence, the risk for errors and omissions is transferred to the DB contractor.

A major point of risk allocation in DB project delivery involves the choice of procurement and payment system. Risk is involved in both the type of procurement system chosen and the point of time in the project development process in which the procurement system is fixed. When DB is used in conjunction with QBS and a GMP, the risks for costs are similar to CMR (except that the DB holds the risk for errors and omissions in the drawings). When DB delivery is used in conjunction with best-value procurement and a fixed price, the design-builder assumes more risk earlier in the process. Primarily, the design-builder is assuming risk for the details of design and the associated costs from time of award through completion of the project. The design-builder commits to a design and a firm price early in the process, and the airport stands at less risk for cost growth.

Issue 7: Lifecycle Costs

The effects of project delivery methods extend to the operation and maintenance phase. The opportunities or barriers that each project delivery method provides with regard to lifecycle costs are discussed below.

DBB

The owner is in control of design details and construction quality assurance submittals and can help tailor these details to a project's long-term lifecycle goals. The owner, through the designer, has the ability to choose the intended lifecycle of all construction components. For example, the designer can specify a pavement mix design that has an expected lifecycle, and the general contractor will bid on that design. Likewise, a designer can closely specify equipment that meets the intended service life. However, DBB allows for little constructor input into lifecycle cost issues.

CMR

The owner keeps the same level of control over the design of the project as in DBB and also benefits from the constructor's advice regarding future costs of the project. The CMR will be able to provide input to design alternatives that impact lifecycle performance. For example, the CMR may have specific knowledge of how locally available material can impact the constructability of a given pavement design or may be able to comment on first cost issues surrounding design alternatives with equal service lives. However, lifecycle performance criteria must be well understood during the development of the GMP. Once a GMP is fixed, the CMR will have difficulty incorporating any changes into the final product. Additionally, the use of fast-tracking in CMR can also add challenges to meeting lifecycle goals.

DB

DB creates the greatest challenges with lifecycle performance because many of the products are not defined at the time of award. The airport can use performance criteria to set lifecycle performance standards and rely on design-builder innovation to achieve these standards. If lifecycle issues are difficult to define through performance criteria, a GMP pricing structure could allow for more owner input than a fixed-price option. In the fixed-price option, the owner needs to keep a close eye on the issue of increasing project lifecycle costs mainly because the design-builder must design to the budget defined by the project's contract amount. This creates a potential conflict with lifecycle costs if the design-builder is struggling to keep the project on budget. In some cases, owners consider multiyear warranties in DB contracts in order to ensure long-term construction quality, but this approach requires resolving many challenging issues (e.g., warranty bond terms, appropriate warranty length, impacts of maintenance, and so forth).

Issue 8: Maintainability

Maintainability is affected by the choice of delivery method in two different areas: level of quality and ease of maintenance. The positive and/or negative effects of each project delivery method on these two areas are described below.

DBB

In DBB, the owner can check the maintainability of the finished design before awarding the project. Having checkpoints in the design phase can help the airport ensure the quality of the design of the end product. However, there is little constructor input into maintainability issues.

CMR

The owner of a CMR project can benefit from all the advantages of DBB and also the constructor's involvement in and advice on maintenance of the end product. This is particularly effective if the constructor has previously operated similar facilities [Logan International Airport].

DB

As the quality control is transferred to the design-builder in DB and details of the design are not known at the time that the project is awarded, many owners have some concerns about the maintainability and quality of the end product. This has led some owners to require multiyear warranties from DB contractors. For projects in which maintainability was a key factor to airport operations, such as a people-mover project, the interviewed airports used DBOM [Dallas/Fort Worth International Airport, Hartsfield-Jackson Atlanta Airport]. The airport can emphasize maintainability issues through performance criteria and best-value award factors. However, if maintainability issues are not well understood at the procurement stage, they will not be incorporated into the DB contract.

Project-Level Issue Summary

The results of the interviews with airports and the literature review show the important role of project-related issues in selecting a delivery method. Some factors—project schedule, project size and technical complexity, and cost control—were chosen by almost all the interviewees as factors that directly influenced their selection of a project delivery method. This section has explained the "pros" and "cons" of each project delivery method with regard to those issues. It has also expanded the discussion to issues like risk management and precise cost estimation, which are also important to consider when evaluating project delivery methods.

Airport-Level Issues

Airport-level issues include issues related to the airport's staff, the airport's control over the project, security, and third-party agreements.

Issue 9: Airport Experience/Staff Capability

This issue mainly concerns the experience of an airport's staff and their ability to properly administer various project delivery methods. This issue is also focused on the quality and competence of an airport's employees and the need for employees with the particular capabilities necessary for successful administration of a selected project delivery method. Owners who have used a project delivery method in the past have a higher level of experience with that method. Also,

availability of experienced staff until project completion should be considered when evaluating staff capability.

DBB

All the interviews show that airports have historically employed the DBB project delivery method and still use this method more than other methods. This experience with DBB can, in some ways, make it a good candidate as a project delivery method (Harrington-Hughes 2002). This depth of staff experience can motivate an airport to use an alternative delivery method or deter an airport from doing so. Some owners who have used DBB in the past may be looking for ways to improve on it by involving the constructor earlier in project development and will therefore try alternative methods. Other owners are comfortable with DBB delivery and therefore hesitant to try new delivery methods [Logan International Airport]. An important issue is the requirement for specific technical expertise in properly administering a design contract and a construction contract. This creates a larger number of required competencies (Touran et al. 2009). The owner in a DBB project must administer two separate contracts for design and construction, which requires a relatively large number of owner employees (AGC 2004, Gordon 1994). The owner's responsibilities in DBB are spread throughout the project lifecycle (interacting mainly with the designer at the beginning of the project and shifting to interact mostly with the contractor after project award); fluctuation in the number of employees required during the project is minimal.

CMR

While most of the interviewed airports have used CMR in their projects, it is a relatively new method for airport projects [Hartsfield-Jackson Atlanta International Airport]. Many airports have some experience hiring a CM as a consultant (or Agency CM). (Please refer to Chapter 2 for a detailed discussion of the CM definition.) Nonetheless, airport staff with DBB experience have most of the skills necessary to manage CMR because of the similarities between CMR and DBB (Touran et al. 2009). This project delivery method can arguably require the least number of owner employees because the CMR can expand to meet the owner's staffing needs (Gordon 1994). While the work can be delegated in CMR, airport staff must have the capability to oversee CMR preconstruction services work (Touran et al. 2009). One missing skill may be negotiating the construction manager's preconstruction services fees and the GMP in CMR. The owner must also be able to manage the relationship between the CMR and the designer. The owner may need to add specific talent to its staff (either as an employee or consultant) if special expertise in managing a CMR contract is desired (e.g., in negotiating the GMP or a construction manager's fee).

DB

There are several airport projects that have been executed using the DB delivery method. Many airports, as well as other public entities, have the managerial experience required for a DB project. Recent research shows that the traditional design and construction engineering tasks performed by public agency professional engineers (e.g., design deliverable approvals and construction inspection) were performed by public agency professional engineers in DB projects, and the owner agencies did not change the size of their staff after implementing DB (Gransberg and Molenaar 2007). The primary difference is in managing a contract that contains the designer and constructor as one entity. This difference affects the manner in which the design-builder is procured (i.e., using the best-value method or QBS instead of bidding based solely on cost), the manner in which the design is reviewed, and some aspects of how construction is overseen by the owner. Additionally, in order to use the DB method, airport staff will need to learn how to conduct project oversight without the presence of a completed design for early features of the work. This may require training and a change of skills for owner employees, which may make DB more difficult to administer (Touran et al. 2009).

A recent study shows that owners tend to put their most experienced staff on DB projects because staff on these projects need to be well prepared to understand conceptual designs, conceptual estimates, and performance criteria. Typically, only the most experienced staff or hired experts (consultants) have these skills (Gransberg and Molenaar 2007). If QBS is used, the owner will need experience in GMP negotiation and payment procedures just as it would if it were using CMR.

Issue 10: Airport Control of Project

Airport control over the details of design, the quality of construction, the complexity of a project, and overall coordination are considered in this section while cost control and time control are discussed elsewhere.

DBB

Interviews done for this research show that DBB gives the owner the most control over the project. The owner in this delivery method may benefit from checks and balances by having the designer and constructor under two separate contracts. Having periodic decision points in DBB, mainly during the design phase, helps the owner control the project's design (Garvin 2003, Harrington-Hughes 2002, Irwin 2003). Having a specific contract based on completed construction documents helps the owner control construction and material quality. Also, if flexibility is required during construction, DBB allows changes to be made during the design phase at little or no cost. However, changes made during construction are usually accompanied by cost increases.

CMR

The owner agency benefits from the involvement of the CM in most of the decisions during the design phase. This will mainly help owners of complex projects (Barnstable Municipal Airport 2007). Although the relationship between the owner and construction manager plays an important role in CMR, the owner still has a high level of control in this method. This delivery method gives as much control and flexibility to the owner in implementing changes in the details of design during the design phase as in DBB. Furthermore, having the construction manager on the team during design makes implementing changes during construction more effective compared with DBB because the CMR will provide a much needed continuity of construction expertise during the design and construction phases. (Walewski et al. 2001, Minchin et al. 2007).

DB

Although DB arguably provides the owner with the same quality of design and construction as DBB (FHWA 2006, Konchar and Sanvido 1998), most professionals and interviewed airports agree that the owner loses control over the details of the design that are not clearly defined in the RFP specifications [Memphis International Airport]. Loss of control over the design and lack of checkpoints have the potential to expose the owner to shortcomings in the quality of design and construction (Gordon & Rees LLP 2005, Irwin 2003, Gransberg and Molenaar 2004). The use of QBS and a GMP pricing structure can give the airport more control if it is willing to fix the GMP in the later stages of design development. The option of negotiating the GMP at a later stage should be weighed against the longer period of cost uncertainty for the owner, which can be a concern for some agencies.

Issue 11: Security

Security imposes another level of technical complexity and a potentially high level of liability on all airport projects. Airport security affects both the design phase and the construction phase of projects. Any change in Transportation Security Administration (TSA) codes and standards

may result in changes to a project design while the project is being constructed. A delivery method with a high level of flexibility would perform best under such circumstances. Interviews with airports did not show any project delivery methods with a clear advantage or disadvantage with regard to security. But it is expected that liability requirements and the need for employee background checks may reduce bid competition, and daily security checks at the entrance gates for laborers and construction deliveries would increase the schedule and increase project costs. The multiple effects of security requirements on airport projects are considered in this section as well as the pros and cons of each delivery method in relation to security.

DBB

This delivery method gives the highest level of flexibility to the owner during the design phase and facilitates any changes in the design before awarding the construction. Unlike alternative delivery methods, the owner can make changes to design requirements at any point during design without having to amend its contracts with the constructor.

CMR

In many CMR arrangements, the design of a project is not complete by the time a not-to-exceed budget has been submitted by the CMR; because of this, additional contingencies and allowances may be built into the costs to reduce the risk of changes in security regulations. Nonetheless, it has been noted that "it is important to make sure that the design of the facility allows for flexibility and potential changes without substantial impact by taking into account future changes in the industry and regulatory requirements" (Bechara 2002). The analysis of the interviews with airports shows that CMR has the best performance with regard to this issue and compliance with tight security controls. This is mainly due to the close collaboration that results among team members in CMR. Additionally, in CMR, time is provided during design for the constructors to perform the required employee background checks. In some airports, the GMP is finalized after the design is complete.

DB

Coping with changing security codes such as the unexpected enactment of the Aviation and Transportation Security Act (ATSA) in November 2001 is more difficult if a project is based on a fast-track, design-build method of construction with a fixed-price contract after completion of the schematic design phase. On a positive note, DB also provides time during design for constructors to complete employee background checks. The use of QBS with a GMP can provide more flexibility in dealing with unexpected security events and will be similar to CMR.

Issue 12: Control of Impact on Passengers and Operations

Ideally, airport operations on both the airside and the landside would not be affected by construction activities. However, direct or indirect short-term interruptions of operations caused by new projects are inevitable. Owners prefer a project delivery method that helps to minimize these impacts on operations and the flow of passengers. This section discusses each delivery method in terms of its ability to allow the coordination of construction activities with airport operations management in order to minimize construction impacts.

DBB

The owner can include the requirements for operations management in the design and prepare bid documents and project schedules based on prevailing operating constraints. The airport's control over the design provides the airport with an option to phase the construction and divide the project into several packages in a way that minimizes impact on operations and passenger flow (Florkowski 2007a).

CMR

Having the CM's expertise in coordinating subcontractors and negotiating with other involved parties helps the airport decrease the negative impact of construction activities. Allocating impact control responsibilities among the increased number of parties involved in a CMR project is a drawback of this delivery method. The opportunity for the constructor to work with operations earlier in the process is a distinct advantage. Additionally, the enhanced ability to phase the project because there is a guaranteed single construction contractor across all phases allows the airport to optimize the impact of construction with operations and passenger flow.

DB

The interviews conducted for this study show that DB has the ability to minimize a project's interruptions of routine airport operations [Tampa International Airport]. The design-builder fully controls the impact of the project on airport operations and must directly implement measures in a project's design and construction schedule to conform to airport operational constraints. The airport can articulate these requirements as project performance criteria or specifications. As in CMR, the opportunity for the constructor to work with operations early in the process in DB is a distinct advantage. Additionally, if minimizing operational impact is critical to project success, the airport can require inclusion of a plan to minimize operational impact in the DB proposals and use it as a key factor in the evaluation and award process (Beard et al. 2001).

Issue 13: Third-Party Stakeholder Input to Design and Construction

This issue concerns the effect of each delivery method on promoting coordination and project-specific agreements with third parties—such as political entities, utilities, adjacent communities, and so forth—involved in the project or affected by it. This issue also encompasses the opportunities afforded by a delivery method to an owner for coping with community input. A delivery method should strive to leverage stakeholder and community input to achieve project goals in a meaningful and transparent fashion.

DBB

Most permitting agencies' procedures have been established on the assumption that a 100% complete design will be available for review prior to permit issuance. Thus, DBB's linear delivery process allows the most time for potentially lengthy negotiations with some project stakeholders. It gives some flexibility and time during the design process for the owner to obtain needed permits/agreements before construction begins. Third parties, on the other hand, have the ability to examine 100% complete designs before a contractor is hired. The disadvantages of completing designs before hiring a contractor may include a lengthy design schedule (including numerous instances of stakeholder inputs that can disrupt the most generous schedules) and also a lack of construction contractor input into the third-party agreements. This delivery method also puts the burden of securing all the permits on the owner.

CMR

The main advantage of having a CM is the constructability advice (for example, construction knowledge and an understanding of construction methods) during the development of third-party agreements. In comparison to DBB, CMR may have a significant effect on getting third-party agreements if the owner makes the responsibility of obtaining these agreements a part of the CMR contract (Touran et al. 2009). In general, the CMR's knowledge of construction processes and sequencing can help clarify various aspects of project impact on communities and institutions; this can increase community confidence and thereby help in obtaining community consent and stakeholder agreements.

DB

The DB process can help move third-party agreements to consummation early in the project delivery process, often before the design is complete. Airports need to get all the important inputs from stakeholders before issuing an RFP because changes in the project after award are disruptive and potentially costly. Airports have experienced both benefits and drawbacks from having the DB contractor on the team before all third-party agreements are in place. As design and construction are awarded in one contract, the time available to develop agreements with other parties can be compressed. Additionally, these agreements must often be written in performance terms because the design is not completed at the time of award. However, the designers and constructors on a DB team often have long-standing relationships with third-party stakeholders that they can leverage for the benefit of the project. Constructors have different approaches to negotiating agreements with third parties than owners, and these approaches can often be very effective (Touran et al. 2009). Additionally, the airport can require the DB contractor to include a public information and outreach program in the project to facilitate stakeholder input during design and construction. A caution is that any third-party change after the award of a fixed price or negotiation of a GMP in a DB delivery method can be costly or difficult to negotiate.

Airport-Level Issue Summary

Airport-level issues directly impact an airport's operations and its project delivery staff. Some of these issues, such as the experience and capability of airport staff, play an important role if a switch is being made from the traditional DBB project delivery method to alternative delivery methods such as CMR and DB. Many airports prefer to use DBB unless their goals cannot be readily achieved by this traditional project delivery method. Other issues presented in this section are specific to airport projects. For example, "control of impact on passengers and operations" mainly concerns the flexibility of each delivery method in relation to project phasing and rescheduling to minimize construction impacts on regular activities of an airport. "Security" is another example of an airport-specific issue. Security codes, tight controls, and background checks decrease competition, complicate project scheduling, and increase project cost. However, when considering airport-level issues in the process of selecting a project delivery method, the most important areas to consider are the owner's control over the project and flexibility in the design phase. In all cases, the airport's ability to articulate well-defined project objectives and a clear scope using the given delivery method is the key to success.

Public Policy/Regulatory Issues

This section examines the choice of project delivery method in relation to public policy and regulatory issues such as existing laws, mandated social programs, labor unions, and other factors that establish the legal environment in which a project must be delivered.

Issue 14: Competition and Local Talent

Each delivery method may affect the level of competition. In many cases, airports are operating under a legal requirement that requires "free and open" competition; for example, Port Columbus International Airport is required by state law to bid out any project more than $25,000. Owners benefit from a competitive market mainly because of the reduction in bid prices. If choosing a certain project delivery method reduces the level of competition among bidders (or reduces the number of qualified bidders), this would be considered a disadvantage. Airside design and construction projects normally have less competition than landside projects because of specialized knowledge, skills, and experience [Logan International Airport].

Currently, the volatility of bid prices in transportation projects is a major concern for the owners of airport projects. Additionally, alternative project delivery methods may inadvertently lead an airport to package projects in sizes that can effectively reduce competition. Local talent can be an advantage or disadvantage of each delivery method depending on the available capacity of local companies. For example, availability of general contractors with DB experience in the area where the airport project is executed should be considered an advantage of DB. On the other hand, some airports may be located in areas where there are relatively few firms familiar with CMR or DB contracting, making the use of alternative delivery methods a disadvantage in those areas.

In the following paragraphs, the ability of each delivery method to facilitate competition and employ local talent is evaluated.

DBB

Compared to other delivery methods, the availability of a relatively large pool of potentially qualified bidders ensures a high level of competition (AGC 2004, Walewski et al. 2001). The owner can benefit from this market competition and get a low bid for its project. This approach also enables the owner to divide the project into smaller packages and bid them out separately to further increase competition. The drawback to the multiprime approach is that the coordination between various contracts may prove difficult.

CMR

Using RFP procedures and taking into consideration qualifications-based factors when evaluating the bidders can help the owners weed out unqualified proposers. The issue in this method is that the selected CMR constructor becomes the de facto winner of the construction contract, giving the owner less competitive leverage when pricing the construction (Irwin 2003). This can be alleviated to some degree by requiring that the project components be bid out competitively among various trade subcontractors. The potentially negative effect of this requirement is that the CM may be reluctant to set a GMP until all the sub-bids are in. The owner can reserve the right to go to regular bidding if it cannot agree on a GMP with the CMR, although that decision may entail some extra cost and schedule delay.

DB

The RFP or qualifications-based procurement process can weed out unqualified DB entities. Nonetheless, the size of the bid package, the experience required to lead a DB team, and the bid preparation costs may reduce the number of qualified bidders (AGC 2004).

Issue 15: Disadvantaged Business Enterprise (DBE)/ Small Business Impacts

The law imposes requirements and provides guidelines for DBE participation on federally funded airport projects [Hartsfield-Jackson Atlanta International Airport, Port Columbus International Airport, Colorado Springs Airport, Denver International Airport]. Project delivery methods may facilitate fair competition for DBEs for airport contracts and reduce burdens on small businesses. The effect of each project delivery method on promoting participation by disadvantaged businesses is discussed below.

DBB

In DBB, the owner has the chance to include requirements for DBE participation in both design and construction contracts. For example, in the RFP for soliciting design services, the owner may stipulate the nature and extent of DBE participation as part of the design team. In the same way, the owner may require that the general contractor perform a preset percentage of construction using DBE subcontractors. Usually, the minimum level (as well as the desired target level) of

participation is stipulated as a percentage of the contract price. On the other hand, the low-bid environment of DBB may force DBE subs to submit dangerously low prices, potentially harming the future viability of these fledgling companies.

CMR

A constructor that submits a proposal for a CMR project is usually more sophisticated in dealing with a design team and understanding project objectives than a DBB general contractor. In QBS, the lack of experience of some DBEs can be a disadvantage. One method to ensure DBE participation is to require a preset minimum (and target) percentage of the GMP for DBE firms.

DB

Lack of experience and sufficient financial strength may prevent a DBE from becoming a lead contractor in DB, but small businesses and DBEs may participate as subcontractors of the design-builder. As the owner is not directly involved in selecting subcontractors and suppliers, requirements for DBE participation as a percentage of the project budget should be included in a DB RFP and then in the contract. This percentage should be based on the number of DBEs associated with the various trades that will be required in the project. The design-builder then periodically reports on the actual payments to all the DBE subcontractors and suppliers. The use of fixed-price procurement early in the project development process will not facilitate the identification of DBE contractors as well as the use of a GMP negotiation later in the process. As the owner has less control in this project delivery approach, the enforcement of DBE participation may be more difficult than in DBB or CMR.

Issue 16: Legal and Statutory Constraints

Research done on federal laws shows that airports are allowed to use alternative project delivery methods (49 USC § 47142). State and local codes may have their own restrictions. Some states mandate that airports go through several justification and approval steps before being allowed to use an alternative project delivery method. Additionally, there may be other legal issues. For example, labor union issues, environmental impact permits, and rules for the bidding process may conflict with the procedures of a project delivery method and make it difficult for the owner to use that delivery method. Also, a well-tested and streamlined procedure for a delivery method, achieved after many applications is considered an advantage for that delivery method. The interactions between each project delivery method and legal and statutory constraints are explored below.

DBB

DBB is accepted as a delivery method for an airport project by all state codes. Relevant procurement processes are well developed, and the details of DBB execution are available nationwide. In this delivery method, the contractor hires laborers directly or through a subcontractor. Union or non-union labor may be used in this method (unless local conditions and considerations limit a constructor's options), and there would be no fundamental opposition to DBB unless the contractor failed to comply with the relevant rules and regulations. The open bid procedure does not conflict with state codes and does not impose any ambiguity or difficulty for the airport if the project is awarded to the lowest bidder. Finally, the procedures are well established, with a long history of application.

CMR

The at-risk CM is usually selected through a qualifications-based process, and then the contract price is determined in a negotiation between the owner and the CMR. This may conflict with state codes that require open bidding for any construction project. The constructor in this project delivery method plays a role similar to the general contractor in DBB, and

there would be no fundamental issues between the unions and the constructor. If there are union issues in the project's location, the CMR's ability to guarantee the maximum price of the project will be at risk, and the CMR may not be willing to absorb the risks of the labor union issues. Unions may support alternative project delivery methods because these methods weight the importance of qualifications over the importance of cost, and unions assert that their members are more qualified than non-union labor (Bearup et al. 2007).

DB

Design-builder selection can be accomplished through best-value or qualifications-based procedures that typically include factors related to the qualifications of the bidder and the proposal. This approach to selection may conflict with traditional hard dollar bidding for some airports with no experience with these procedures. Also, the DB entities on large megaprojects (>$100 million) are usually joint ventures that dissolve after the end of the project, and this may make the process of dealing with unions a bit complicated as the joint venture entity may not be a signatory to the prevailing union agreements in the area. Awarding the design to a design-builder in places where public design engineers have their own unions (e.g., California) may cause public design engineers to view the use of DB as a threat to their job security. As with CMR, labor/craft unions may support alternative delivery methods in which qualification rather than cost is the basis of the award because unions assert that their members are more qualified than non-union labor (Bearup et al. 2007). Choice of procurement method may also affect the ability of some airports, as they may not be allowed to use a QBS procurement system [Hartsfield-Jackson Atlanta International Airport]. Also, sometimes environmental agencies may require a complete design before issuing the necessary permits. This will create an obstacle for the use of DB.

Issue 17: Sustainability and LEED Certification

Sustainable design and construction features are becoming more common and may become mandatory in the future for public infrastructure projects. Thus, it is important to gauge a project delivery method's ability to include these features in accordance with the owner's needs. The U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification is often used by public agencies as a means to articulate their desire to design and build both energy-efficient and environmentally responsible projects. For example, Sacramento International Airport's preferred concept for the new Central Terminal B includes LEED certification as an objective. Although LEED certification has not become a requirement in airport projects, how each delivery method functions with regard to this issue can be a benefit or a drawback. For example, one benefit of establishing LEED as a criterion is that it can be used as a metric to evaluate sustainable design and construction options regardless of whether LEED certification is sought for the project. LEED prerequisites (including selection of site and construction activity pollution prevention) can yield environmental benefits while reducing regulatory risk. On the other hand, sustainability requirements may increase project costs because of extra technical features and documentation, as well as the requirement to have certified project personnel. One important fact to remember is that sustainability standards are evolving. The adoption of LEED criteria as a selection requirement may need to be phrased to indicate that the most current iteration of LEED criteria should be consulted rather than a particular, existing standard.

DBB

With DBB, the owner has a clear opportunity to define sustainable design intent and shape social and environmental impact. This method presents opportunities to promote and enhance sustainable design criteria by allowing for materials research and the development of strategic

stakeholder input. The builder's lack of input in DBB means that there will be little opportunity to take advantage of builder knowledge of sustainable design, and in certain cases, the owner may not achieve its sustainability goals (e.g., getting a LEED certificate for the project).

CMR

With CMR, the owner has a unique opportunity to realize economic returns for sustainable systems performance as well as to use sustainable construction experience as an evaluation factor for the selection of a builder. With this project delivery method, sustainable construction features are more likely to be implemented because of the cooperative nature of the owner/constructor contracts. The contractor's early involvement in the design process can help in performing meaningful industry-based, cost-benefit analyses for various LEED components.

DB

The owner can clearly articulate expectations regarding sustainability by assigning weight to sustainability in relation to other factors in the DB evaluation plan. This can be done with either a best-value process or QBS. The design schedule could, however, impact public participation and thereby limit social equity issues. Due to the normally time-consuming processes associated with municipal and state requirements for mandatory announcement and the convening of public hearings, certain sustainability measures—such as wetlands mitigation and avoidance of undeveloped areas—raise concerns for eminent domain and brown-fields redevelopment that can impact time performance. There is some evidence that the use of DB may hamper the objective of achieving LEED certification. This is due to the perception of risk by the DB contractor when considering whether to bid on a DB project with LEED goals. The owner needs to be careful to define the project scope and goals clearly to ensure reasonable competition, especially if LEED certification is desired.

Public Policy/Regulatory Issue Summary

An airport has little if any ability to change public policy or regulatory issues. These issues include specific legal or governing body policy constraints on project delivery method use and legislative requirements for public works projects. Many of these issues are essentially go/no-go factors that may eliminate a delivery method from any further consideration in the decision-making process (e.g., methods not allowed per state statute or local governing ordinance). While some issues discussed in this section are found to have minimal impacts on decision-making (e.g., DBE impacts) there are some other issues that strongly affect project delivery method selection. Competition and local talent is one of these issues. The researchers found that competition and availability of local talent are of relatively high importance for decision-makers and can sometimes become a driving decision-making factor.

Other Issues

The "Other Issues" category consists of issues that are important to project success but not categorized previously in this chapter.

Issue 18: Adversarial Relationships

Airport projects can be hampered by conflicts between parties to the design and construction contracts. The higher the level of adversarial relationships in a project, the more likely it is that the project will suffer from cost, schedule, and quality problems. Delivery methods define the relationships among all project parties. If the project delivery method encourages project parties to

work together as a team to achieve project goals and characteristics, it is considered a benefit. Conversely, if the project delivery method increases the possibility of adversarial relationships, it is considered a detriment.

DBB

This delivery method can create an adversarial relationship among the parties to the contract—mainly between the owner and the construction contractor (Irwin 2003, Mahdi and Alreshaid 2005, Walewski et al. 2001). Furthermore, the engineer and the contractor may assume adversarial roles as one is in charge of approving the other's work. The division of responsibilities may also result in these two parties blaming each other in case of project failures or during major disputes (Halpin 2006).

CMR

The inclusion of the construction contractor during the design phase in e CMR builds constructive teamwork and facilitates project team formation (Irwin 2003, Minchin et al. 2007) although it requires extensive coordination of consultants and/or subcontractors.

DB

Having a single point of responsibility for design and construction, as in the DB method, decreases the potential for conflict between the engineer and constructor (Halpin 2006, Harrington-Hughes 2002, Walewski et al. 2001). Although in DB there should be less conflict between the designer and the constructor (since they are both on the same team and they are jointly responsible to the owner for the success of the project.), instances of internal disputes are sometimes observed in DB projects (Touran et al. 2009). It is worth mentioning that design-builders may be deterred from submitting claims to owners who have future DB projects because they will want to avoid decreasing their competitiveness for future projects awarded on a QBS system by making the owner angry with a claim.

Issue 19: Construction Claims

The effect of each project delivery method in exposing the airport to potential conflicts and claims is discussed below. If a delivery method can reduce the number of construction claims, that delivery method is a favorable choice, and if it increases the possibility of construction claims, it is an unfavorable choice.

DBB

This method typically has the highest occurrence of claims and disputes. Disputes often arise over authority, responsibility, and quality (Walewski et al. 2001). Furthermore, as the owner is responsible for design completeness, errors and omissions claims are common in DBB projects. Some contractors may bid low to win a job and try to enhance their final profit margin through claims and change orders, especially if design errors or ambiguities are present in the construction documents. Studies have shown that this delivery method resulted in the highest rate of cost growth, which could be an indication of a large number of claims (Konchar and Sanvido 1998).

CMR

Assuming a well-structured contract, there is less possibility for claims and disputes in CMR once a GMP is agreed upon and the contract is signed. Because the CMR is present during the design process, there is less need for information and clarification of the design documents. Some professionals think that this method results in very few construction claims (Touran et al. 2009). The QBS methodology creates an effective deterrent to initiating claims by requiring the CMR to

be successful on the current contract in order to be competitive for future projects. The QBS process may reduce the possibility of hiring litigious contractors.

DB

Analysis of the interviews conducted for this study shows that the DB delivery method is less prone to claims and disputes, assuming a well-structured contract. For example, claims for design errors, a major source of DBB contractors' complaints, are reduced considerably in DB. At the same time, early pricing leaves the owner vulnerable to claims for scope that was missing in RFP. The QBS methodology creates an effective deterrent to initiating claims by requiring the design-builder to be successful on the current contract in order to be competitive for future projects. It has also been shown that the size and frequency of change orders are smaller in DB projects (Riley et al. 2005).

Other Issue Summary

This section covers two important issues not directly addressed in other sections. Both of these issues concern relations among parties involved in a project. Construction claims and adversarial relations can hamper project success and shift the owner's focus from project success and quality to dispute resolution.

Conclusion

The analysis done in this chapter is not deterministic. It only describes the advantages and disadvantages of delivery methods in relation to each of the pertinent issues discussed, based on material found in the literature or information gathered during airport interviews. This description, in turn, can be used to help identify the strengths or weaknesses of each delivery method in relation to important factors that can affect project goals. This analysis provides a broad picture of the issues affecting project delivery methods and develops a basis for the decision system that is introduced in the chapters that follow.

CHAPTER 4

Tier 1—Analytical Delivery Decision Approach

Introduction

No single project delivery method is appropriate for every project. Each project must be examined individually to determine how it aligns with the attributes of each available delivery method. The Tier 1—Analytical Delivery Decision Approach (Tier 1 approach) provides airports with a structured approach to choosing the most appropriate project delivery method for an individual project. The Tier 1 approach has three primary objectives:

- Present a structured framework to assist airports in examining 19 pertinent issues involved in the project delivery decision,
- Assist airports in determining whether there is a dominant or obvious choice of project delivery method, and
- Provide a structure for documenting the project delivery decision in the form of a Project Delivery Decision Report.

The Tier 1 approach provides a framework for airports to use in defining project goals and examining the advantages and disadvantages of each delivery method within the context of these goals. The aim of this approach is to help airports understand project delivery method attributes and determine whether their specific project goals align with the attributes of a particular delivery method. The Tier 1 approach also provides a go/no go review to determine whether one or more project delivery methods should be excluded from the examination.

At the completion of the Tier 1 approach, there is a possibility that an airport may not have one clear and logical choice for a project delivery method. If this is the case, the airport is advised to move on to the Tier 2 approach with the best delivery method options yielded from the application of the Tier 1 approach and create a more detailed analysis to select the final project delivery method.

The Tier 1 approach includes six distinct steps listed below and shown in Figure 4-1:

Step 1. Create Project Description
Step 2. Define Project Goals
Step 3. Review Go/No-Go Decision Points
Step 4. Review Project Delivery Method Advantages and Disadvantages
Step 5. Choose Most Appropriate Project Delivery Method
Step 6. Document Results

The objective of Step 1 is to create a project description in sufficient detail for documenting the project delivery decision. A template is provided to assist airports in describing the appropriate level of detail (please see Appendix C, available on the TRB website. Go to www.trb.org and search for "ACRP Report 21"). The description is provided to summarize only the key variables

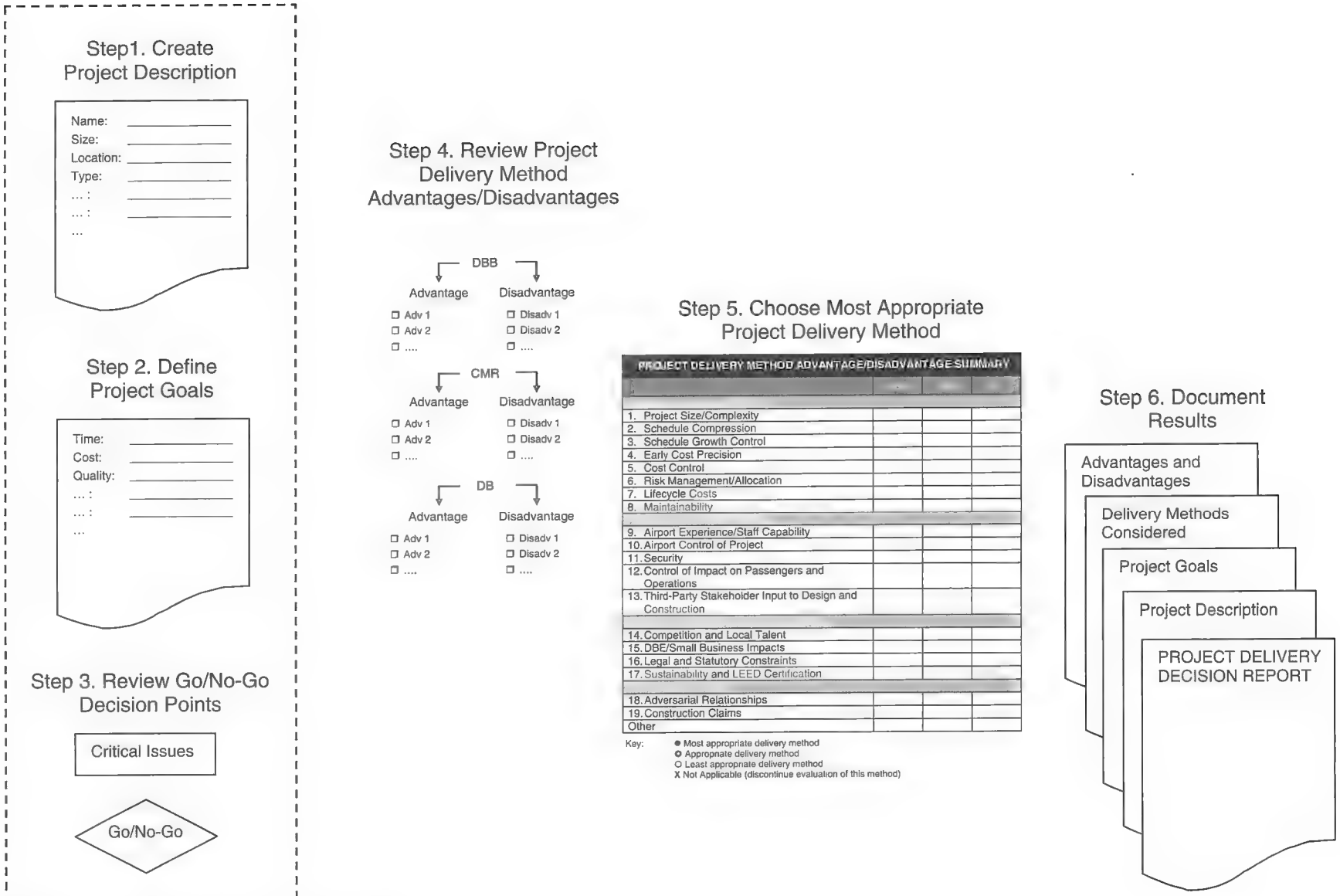


Figure 4-1. Overview of Tier 1 approach.

and provide a "snapshot" of the project scope at the time when the project delivery decision was made.

Research and practical experience have shown that the definition of project goals is a key success factor in the project delivery decision. The objective of Step 2 is to provide guidance to airports on how to write and rank their project goals. The guidance provides general categories for goals.

The objective of Step 3 is to exclude those project delivery methods from consideration that are not viable options. A legal review of project delivery and procurement laws in the United States revealed that some alternative delivery methods are not allowed in all states. There are additional schedule and third-party issues that could exclude a delivery method from consideration. Step 3 describes a quick go/no-go decision process to determine whether a delivery method should be excluded from consideration.

Step 4's primary objective is to present a comprehensive listing of generic *potential* advantages and disadvantages of each delivery method in relation to 19 pertinent issues. *These potential advantages and disadvantages must be examined in the context of each individual project.* Variations in the *project* characteristics, the *people* involved, and the *processes* used by an airport will determine whether the potential advantages or disadvantages are actual advantages or disadvantages for a particular project. In Step 4, airports are asked to consider actual advantages and disadvantages and rate each project delivery method as one of the following: "most appropriate," "appropriate," "least appropriate," or "not applicable" for each of the 19 issues. A form for this rating and a structure for documenting comments are provided.

The objective of Step 5 is to make the final project delivery choice, if a dominant or obvious choice exists. Upon transferring the 19 individual ratings from Step 4 into an overall summary table, airports are asked to determine whether there is a dominant choice. Step 5 asks the airports to consider the significant benefits of what appears to be the most appropriate delivery method as well as any risks or fatal flaws of that delivery method. If a dominant method is not apparent, the user will document the results of the Tier 1 approach and move on to the Tier 2 approach for further analysis of the most applicable methods emerging from the Tier 1 analysis.

The objective of the final step, Step 6, is to clearly document the Tier 1 decision in the form of a Project Delivery Decision Report. The report will provide an archival record for the project delivery decision. It will serve to communicate the decision to interested stakeholders and to justify the decision if issues arise, even years later. The report is organized into sections that follow the five previous steps in the Tier 1 approach—project description, definition of project goals, go/no-go decision points, advantages and disadvantages, delivery method decision, and any relevant appendices.

Application of the Project Delivery Selection System

While the project delivery selection system outlined in this guidebook provides a structured approach, selecting a project delivery system is a complex task. The time it takes to make a sound and justifiable decision should not be underestimated. On simple projects with knowledgeable personnel, the process may take only a few hours. However, on more complex projects, a project team would be more likely to take multiple days to complete and document the decision. The research team would like to offer a few tips for using the system to help ensure success:

- **Apply the system in a group setting.** Conducting a project delivery decision with this guidebook is intended to be an interactive process. Although a single person could answer all of the questions, it is advisable to adopt a team approach due to the wide range of critical issues that need to be analyzed and stakeholders who will be impacted by the decision. The team

approach, in addition to being required to obtain accurate answers, will also facilitate a meaningful dialogue and common understanding of the reasoning behind the project delivery decision. In some cases, it may be helpful to have the delivery decision facilitated by a consultant who is familiar with the airport and the local design and construction market.

- **Select a diverse decision team.** The pertinent issues requiring analysis include funding constraints, schedule constraints, federal/state/local laws, third-party agreements, project-level issues, airport-level issues, and public policy/regulatory issues. A diverse group of individuals should be assembled to address all of these separate items. Decision team members will vary with each project and the airport's available staff, but typical functions that should be represented include upper management, legal staff, planners, engineers, construction administrators, maintenance staff, and possibly any impacted external stakeholder representatives.
- **Prepare for the meeting.** It is suggested that the entire decision team review the project delivery selection system format prior to meeting as a group. At a minimum, each member should read the pertinent issues prior to the meeting. Include an agenda for the meeting and use the forms provided in Appendix C for documenting the meeting. Step 1: Create Project Description can be completed prior to the meeting. Step 2: Define Project Goals can be created prior to the meeting as well, but it is advisable to come to a common understanding of the goals in the group setting.
- **Plan for review of the Project Delivery Decision Report.** Applying the project delivery system described in this guidebook will result in a Project Delivery Decision Report. It is advisable to plan time for all participants in the decision process to review and comment on this report once it is complete.

Step 1. Create Project Description

The first step in the Tier 1 approach involves the creation of a concise project description that serves to communicate the important project characteristics to the decision-makers and also to document the project scope for the Project Delivery Decision Report. Projects differ in scope of work and major elements (e.g., people involved, physical project characteristics, project duration, project budget, and so forth). These distinguishing parameters affect project delivery method selection. Airports should choose the most appropriate delivery method on the basis of the project requirements and the opportunities that each delivery method can provide for them. Please see Appendix C for a typical template for project description and goals.

The objective of creating a project description is to explain the project in sufficient detail to document the project delivery decision. The project description should be concise and also comprehensive. It should include necessary information about the project and address all aspects of the project that may influence project delivery method selection. The intent of the project description is to provide a "snapshot" of the project scope at the time in which the project delivery decision was made. The project description will serve to communicate the decision to interested stakeholders and to justify the decision if issues arise years later. Below is a checklist of the important project characteristics that should be covered in the project description:

- Project Name
- Location
- Major Features of Work
  - Runway
  - Apron
  - Terminal
  - Other
- Estimated Project Budget
- Estimated Project Delivery Period

- Required Delivery Date (if applicable)
- Source(s) of Project Funding
- Project Site Dimensions or Project Limits
- Security Issues or Concerns
- Rate of Return on Capital Investment/Payback Period (if applicable)
- Major Schedule Milestones
- Major Project Stakeholders
- Labor Union Status
- Major Challenges (as applicable)
  - With Permitting and/or Environmental Approvals
  - During Construction Phase
  - During Operation and Maintenance
- Main Identified Sources of Risk
- Sustainable Design and Construction Requirements

Step 2. Define Project Goals

Defining and communicating a concise set of project goals is perhaps the most important element in selecting an appropriate project delivery method. The importance of project goals in delivery method selection cannot be overemphasized. The definition of project goals is a key success factor not only in the project delivery decision, but also in the development of procurement documents and the administration of a project. The project will have technical goals that must be met (e.g., anticipated passenger/cargo throughput, design standards, safety standards, and so forth) and will also have performance goals that must be met regarding time, cost, quality, maintainability, and sustainability. Performance goals typically drive the project delivery decision.

At project inception, the airport must identify the various performance factors of the project to meet its requirements. Generally, these performance factors will fall into the categories of cost, schedule, and quality as defined by the technical design. Of these three factors, a project will normally have one that is the most important for the project's ultimate success—the preeminent factor. In order to achieve goals related to this factor, an airport would be willing to sacrifice pieces of the other two factors.

A clear and concise definition of project goals not only assists with selecting an appropriate project delivery method, it also provides a clear measure for project success and clear directions for the construction manager or design-builder in completing the project. Project goals set the stage for decision-makers throughout the project lifecycle and keep project priorities before decision-makers as they analyze different alternatives. Project goals influence choice of procurement method, risk-allocation strategies, contracting, monitoring progress, and, at the end of the project, evaluating project performance.

To define project goals, thinking in terms of performance categories can be helpful. Time, cost, quality, and suitability are common categories. Table 4-1 provides some generic goals in these categories.

Choosing the goals that apply to a specific project is a first critical step in an airport's selection of a delivery method. The second, and equally important step, is the ranking of the goals. On every project, there are tradeoffs among schedule, cost, and quality. It is to the project's benefit if the airport, designers, and constructors are aware of, understand, and are in agreement with these project goals. For example, if a goal to accelerate the start of project revenue is ranked first and a goal of completing the project on budget is ranked third, the ranking of these goals provides the team

Table 4-1. Examples of generic project goals.

Schedule • Minimize project delivery time • Complete the project on schedule • Accelerate start of project revenue	Quality • Meet or exceed project requirements • Select the best team
Cost • Minimize project cost • Maximize project budget • Complete the project on budget	Sustainability • Minimize impact on the environment • Achieve LEED Certification

with a clear direction: an increase in budget may be acceptable if it can accelerate the start of project revenue.

As previously stated, understanding and communicating a concise set of project goals is perhaps the most important element in selecting an appropriate project delivery method. Airports should take the time to identify project goals and achieve consensus on their relative importance. This time will be well spent as it will make the project delivery decision clearer. Defining and ranking project goals will also help to define and communicate the criteria for determining overall project success, thereby informing designers and constructors of the airport's project performance measures. Please see Appendix C for a typical template for project description and goals.

Step 3. Review Go/No-Go Decision Points

Among the pertinent issues that affect the project delivery decision, there are certain issues that render one or more delivery methods inappropriate. These issues involve project schedule constraints; federal, state, and local laws; and third-party agreements. These issues and their relation to the three primary delivery methods are shown in Table 4-2. The airport needs to review these issues to determine whether they eliminate any of the delivery methods. In other words, the airport should make a go/no-go decision based on these pertinent issues. The result of this go/no-go study is a listing of delivery methods available to the airport and a documentation of those that are not available for further consideration. The flowchart in Figure 4-2 depicts a step-by-step approach to the decision; a description of the approach follows.

As depicted in the flowchart in Figure 4-2, the airport should first conduct research into the pertinent issues of project schedule constraints; federal, state, and local laws; and third-party agreements. The airport should review any major milestones that could create schedule constraints that would prohibit a traditional DBB delivery (e.g., an aggressive fixed end date, funding availability windows, and so forth). Next, federal, state, and local laws can be researched by the airport's general counsel to identify any constraints that must be met during the project

Table 4-2. Go/no-go issue summary.

Issue	DBB	CMR	DB
Project Schedule Constraints	✓ / X		
Federal/State/Local Laws		✓ / X	✓ / X
Third-Party Agreements			✓ / X
Others	✓ / X	✓ / X	✓ / X

✓ / X = Go/no-go decision point. Shaded areas do not need to be considered by the user.

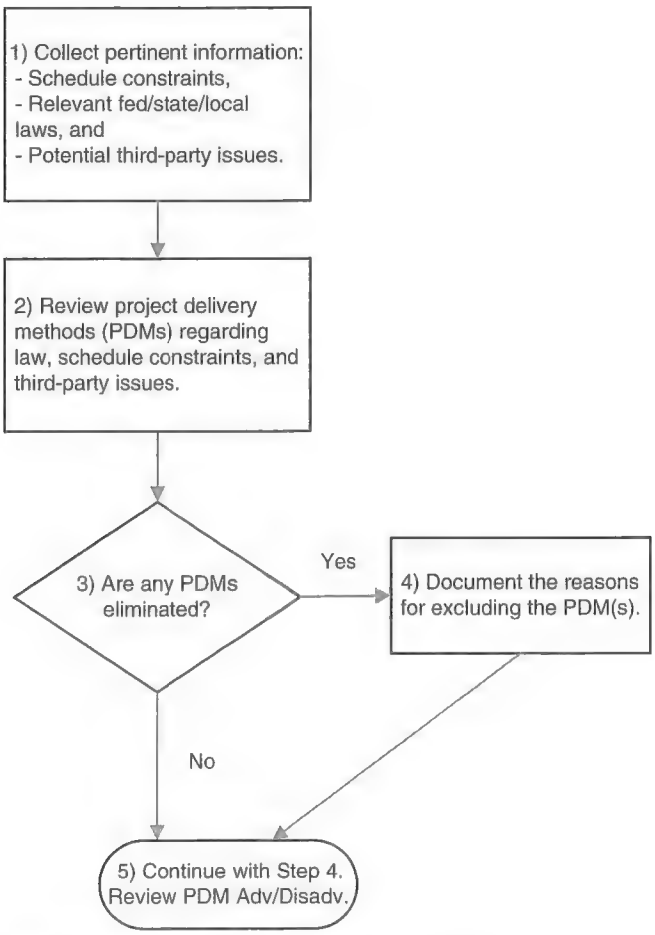


Figure 4-2. Go/no-go decision points.

delivery method selection process. For example, a jurisdiction with a law that requires award of construction contracts to the low bidder may have to adopt the low-bid DB award method in order to use DB project delivery (this constraint may rule out the use of DB in such circumstances). The airport then needs to determine the third-party agreements that will be required (e.g., local municipalities, utilities, permitting, and so forth).

The airport's next step is to analyze the documents and information in relation to the constraints of each delivery method. As depicted in Table 4-2, each of the issues may exclude one or two of the delivery methods from further consideration. For example, if an airport project is located in a state where the law does not authorize CMR and the project is using state funding, this airport can eliminate CMR from the list of available options. Details follow for each of the go/no-go issues.

Project Schedule Constraints

The traditional DBB delivery method is a linear process that requires the longest delivery period of all three methods. If a DBB project delivery will not yield a finish date within the project's constraints, DBB need not be considered further. As mentioned in the previous section on project goals, project schedule can be a preeminent factor in project success. Airports frequently give schedule first priority among competing project goals. Airports most fre-

quently cite shortening of project duration as the reason for using alternative project delivery methods.

An example of another kind of schedule constraint would be an airport that would like to award construction before the design is complete. The DBB method will not accommodate this constraint. This kind of schedule constraint may occur when an airport has a fiscal year budget for construction and needs to award the project before the design is finished or when the airport has an opportunity to complete a portion of the project during an early work window before the design is complete (e.g., beginning construction before the end of the construction season).

Federal/State/Local Laws

When a project is funded with federal, state, or local money, it will need to follow the applicable procurement and construction laws. While some states have fully authorized airports to use CMR and DB, there are still some states that prohibit the use of one or all alternative methods. In the spectrum between states that allow full use of alternative methods and those that prohibit them entirely, there are some states that allow alternative project delivery methods with certain conditions (e.g., requiring extra approvals, putting dollar value limits on the volume of DB or CMR contracts, or putting limits on the number of projects using an alternative delivery method each year). It should also be noted that these laws change frequently, and each airport is responsible for checking the relevant state and local laws.

Third-Party Agreements

All major airport projects affect third parties and require agreements to manage the impacts. Some third parties require a completed set of construction documents to execute an agreement. In this case, the requirement for a complete design renders DB inappropriate. For example, if the project's physical boundaries are adjacent to a local municipality, a full set of drawings may be required by the municipality prior to signing an agreement or a memorandum of understanding (MOU). In such a project, depending on the circumstances and the rigidity of the third party, DB might be eliminated from the list of available options.

Upon reviewing these three go/no-go issues, airports will have a list of viable delivery methods to further consider. Additionally, they should document the reasons for excluding any methods from further consideration. Table 4-3 provides a form for summarizing this go/no-go analysis.

Table 4-3. Go/no-go summary form.

Project Schedule Constraints			
Federal/State/Local Laws			
Third-Party Agreements			
Other			

✓ = Applicable for further study. X = Not applicable (discontinue evaluation of this method).
Shaded areas do not need to be considered by the user.

Comments _____

Step 4. Review Project Delivery Method Advantages and Disadvantages

Step 4 of the project delivery decision involves a critical examination of the advantages and disadvantages of each remaining delivery method. There is no single project delivery method that is appropriate for every project. The objective of the critical examination is to determine how well each project delivery method aligns with project goals, project characteristics, airport characteristics, policy/regulatory issues, and lifecycle requirements.

In Step 4, airports examine 19 pertinent issues that affect project delivery method selection (the 19 issues are described in detail in Chapter 3 of this guidebook) and rate the appropriateness of each delivery method in relation to each issue. For each issue, an Advantages/Disadvantages Form and an Advantages/Disadvantages Summary Table are provided. To determine the appropriateness of each project delivery method in relation to a particular issue, airports should understand the issue, analyze the issue as it relates to the delivery methods, and complete the Issue Advantages/Disadvantages Summary Table. These three actions are described in more detail in the following:

- **Understand the issue.** Read the brief description of each issue. Refer to Chapter 3 for an expanded description of the issue if needed.
- **Analyze the issue as it relates to the delivery methods.** Using the Advantages/Disadvantages Form provided, read the issue statements listed for each pertinent issue for each delivery method. After reading the issue statements, determine whether the issue statement is an *advantage or disadvantage as it applies to the particular project in question.* Please note that an issue statement may be either an advantage or a disadvantage depending on the characteristics of the project, the owner, or the market. Again, refer to Chapter 3 for an expanded description of the issue if needed. *Analyze each issue statement, determine whether the issue statement is an advantage or disadvantage, and document the determination in the Advantages/Disadvantages Form with any relevant notes. Note: it is not necessary to label each issue statement as an advantage or disadvantage, focus only on the important issue statements under each pertinent issue for the project in question.*

  Also note that one can add to the columns in Tables 4-4 through 4-22. This happens if, in a project, the decision-maker decides to include more than one type of DB procurement method. Refer to the section in Chapter 2 titled "Definitions of the Delivery Methods" for procurement options. DB procurement options considered in the Tier 1 approach are primarily Best-Value Procurement with Fixed Price and Qualifications-Based Procurement with Negotiated Price. DB Low Bid is an option, but it is not recommended in this guidebook for the majority of DB projects. Note that for each pertinent issue, the same issue statements will be considered for any DB procurement option. The user will respond to only those issue statements that are relevant to his choice of DB procurement option. If, for whatever reason, the decision-maker decides to consider more than one type of DB, he can copy the sections on DB and fill in each copy with one DB procurement option in mind. Also, a new column can be added to Tables 4-4 through 4-22 to allow a comparison of those DB options with other project delivery methods. Note that if any of the summary tables (Tables 4-4 through 4-22) include more than one DB option, this will need to be carried over to Table 4-23, in which the summary ratings from each issue analysis are recorded.
- **Complete the Issue Advantages/Disadvantages Summary Table.** Review the advantages and disadvantages associated with each delivery method and analyze their implications. In the Issue Advantages/Disadvantages Summary Table, rate the appropriateness of each project delivery method using the following system:
  - ● – Most appropriate delivery method
  - **O** – Appropriate delivery method
  - ○ – Least appropriate delivery method
  - **X** – Not applicable (discontinue evaluation of this method)

Project-Level Issues

Issue 1: Project Size/Complexity

This issue concerns the airport project's dollar value and complexity based on the type of project.

Advantages/Disadvantages Form—Project Size/Complexity

Design-Bid-Build (DBB)		
❒ DBB has been shown to work on projects of all sizes and levels of complexity, but the research case studies found that airports tend to select DBB on smaller projects. ❒ As projects grow in size and complexity, the amount of owner staffing required to oversee DBB can become very large.		

Construction Manager at Risk (CMR)		
❒ CMR has been shown to work on projects of all sizes and levels of complexity, but the research case studies found that airports tend to select CMR on larger and more complex projects. ❒ On projects of large size and complexity, CMR can use multiple bid packages to optimize responses from proposers, but this approach results in more complexity in management.		

Design-Build (DB) Please specify procurement system: (		
❒ DB has been shown to work on projects of all sizes and levels of complexity, but the research case studies found that airports tend to select DB on larger and more complex projects. ❒ Some owners have noted that DB can facilitate better management of large projects due to the single source of responsibility. ❒ As projects grow in size and complexity, there can be large peaks in owner staffing requirements with DB (e.g., during RFP development, during design review, etc.). ❒ As projects grow in size and complexity, best-value procurement will require design-builders to assume more risk, and QBS procurement will make it more challenging to negotiate prices.		

Table 4-4. Project size/complexity advantages/ disadvantages summary.

Issue	DBB	CMR	DB
1. Project Size/Complexity			

Key: ● Most appropriate delivery method
◘ Appropriate delivery method
○ Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

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Issue 2: Schedule Compression

From the owner's viewpoint, a delivery method can affect project schedule in two different ways: (1) shortening the schedule and (2) controlling schedule growth.

Advantages/Disadvantages Form—Schedule Compression

Design-Bid-Build (DBB)		
❒ DBB is the base case and will take the longest of the three delivery methods. ❒ If an airport is willing to take on coordination responsibility, DBB projects can be awarded to multiple prime contractors to speed the process. ❒ Studies have shown that, *on average,* DBB is slower than CMR and DB.		

Construction Manager at Risk (CMR)		
❒ CMR can be used to facilitate fast-tracking or the ability to bid multiple design packages. ❒ There is a risk that overlapping design and construction packages may create delays if not properly coordinated. ❒ Fast-tracking schedules require owner effort in design and construction reviews and do not guarantee time savings. ❒ Studies have shown that, *on average,* CMR is faster than DBB, but slower than DB.		

Design-Build (DB) Please specify procurement system: (		
❒ Provides a single point of responsibility (DB contractor) for schedule compression. ❒ All case studies showed that airports selected DB with the primary goal of compressing the schedule. ❒ A compressed schedule will require airport effort in design and construction reviews. ❒ Studies have shown that, *on average,* DB is faster than both CMR and DBB. ❒ DB procurement methods do not significantly affect schedule compression.		

Table 4-5. Schedule compression advantages/ disadvantages summary.

2. Schedule Compression			

Key: ● Most appropriate delivery method
◘ Appropriate delivery method
○ Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

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Issue 3: Schedule Growth Control

This issue concerns the ability of each delivery method to control and prevent growth in a project's schedule.

Advantages/Disadvantages Form—Schedule Growth Control

❒ Research on project delivery methods suggests that DBB is likely to yield the highest schedule growth due to change orders ❒ There is a lack of opportunity to compress a project schedule if problems occur due to the linear nature of DBB. ❒ Studies have shown that, *on average,* DBB has more schedule growth than CMR and DB.		

Construction Manager at Risk (CMR)		
Issue Statements	Advantage	Disadvantage
❒ CMR facilitates fast-tracking, or the ability to bid multiple design packages, which can be helpful in limiting schedule growth if problems occur during project development.		
❒ There are risks that overlapping design and construction packages may create schedule growth if not properly coordinated.		
❒ Studies have shown that, *on average,* CMR has less schedule growth than DBB, but more than DB.		

Design-Build (DB) Please specify procurement system: ( )		
[illegible]	[illegible]	[illegible]
❒ Provides a single point of responsibility (DB contractor) to combat schedule growth.		
❒ DB projects using a lump sum contract typically fix project end dates early in the project development process when compared to DBB or CMR.		
❒ Unlike DBB and CMR, owners will be shielded from schedule-related change orders stemming from errors and omissions in plans.		
❒ A compressed schedule will require airport effort in design and construction reviews.		
❒ Studies have shown that, *on average,* DB has less schedule growth than both CMR and DBB.		
❒ DB procurement methods do not significantly affect schedule growth control.		

Table 4-6. Schedule growth control advantages/ disadvantages summary.

Issue	DBB	CMR	DB
3. Schedule Growth Control			

Key: ● Most appropriate delivery method
O Appropriate delivery method
O Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____
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_____
_____
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Issue 4: Early Cost Precision

Early and precise project cost estimation is always sought by airports. This issue concerns the effect of each delivery method on accurately predicting a cost estimate.

Advantages/Disadvantages Form—Early Cost Precision

Design-Bid-Build (DBB)		
❒ Construction costs are not fixed (or locked in) until design is 100% complete, but costs are known at bid time, before construction begins.		
❒ Constructability advice and contractor innovations are not available to save cost until post bid.		
❒ The DBB process is prone to change orders and cost growth after award.		

Construction Manager at Risk (CMR)		
❒ CMR can be used in conjunction with a GMP pricing structure, which can be useful in negotiating and controlling costs.		
❒ Costs will be known earlier than with DBB, but perhaps not as early as with DB.		
❒ CMRs generally have experienced estimating and construction staff that can help to develop reliable estimates earlier in the process.		
❒ If a GMP pricing structure is used, owners should have experience in estimating and negotiating prices.		
❒ If the airport/funding agency requires that the subcontractors be selected through low-bid procurement, the construction manager may be unwilling to agree to GMP before all subcontractors' bids have been received.		

Design-Build (DB) Please specify procurement system: (		
❒ Costs will be known earlier in the project delivery process when compared to DBB or CMR.		
❒ If a lump sum pricing structure is used, costs will be fixed early in the project development process, but constructors must develop prices before plans are 100% complete and therefore must assume some risk in pricing.		
❒ If a GMP pricing structure is used, owners should have experience in estimating and negotiating prices.		
❒ If the airport/funding agency requires that the subcontractors be selected through low-bid procurement, the construction manager may be unwilling to agree to GMP before all subcontractors' bids have been received.		

Table 4-7. Early cost precision advantages/ disadvantages summary.

Issue	DBB	CMR	DB
4. Early Cost Precision			

Key: ● Most appropriate delivery method
◘ Appropriate delivery method
○ Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

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Issue 5: Cost Control

Cost control is a project performance criterion and can drive owners to select a particular delivery method according to its ability to (1) reduce total project costs and (2) minimize project cost overruns.

Advantages/Disadvantages Form—Cost Control

Design-Bid-Build (DBB)		
❒ With the exception of change orders, costs are known at bid time, before construction begins. ❒ Research suggests that, on average, DBB is likely to yield the highest cost growth due to change orders.		

Construction Manager at Risk (CMR)		
❒ CMR can be used in conjunction with a GMP pricing structure, which can be useful in negotiating and controlling costs. ❒ If open book pricing can be used, all costs will be known by the owner. ❒ If multiple bid packages are used, the overall project cost could grow if later bid packages cost more than estimated. ❒ Early constructor involvement or construction advice can lead to cost savings through value engineering and constructability reviews. ❒ If a GMP pricing structure is used, owners should have experience in estimating and negotiating prices.		

Design-Build (DB) Please specify		
❒ Studies have shown that, *on average,* DB has been shown to have lower average cost growth than DBB or CMR.		
❒ Unlike DBB and CMR, owners will be shielded from cost-related change orders stemming from errors and omissions in plans.		
❒ If open book pricing can be used, all costs will be known by the owner.		
❒ The integrated nature of DB teams can lead to cost savings through inherent value engineering and constructability reviews.		
❒ If a GMP pricing structure is used, owners should have experience in estimating and negotiating prices.		

Table 4-8. Cost control advantages/disadvantages summary.

	DBB	CMR	DB
5. Cost Control			

Key: ● Most appropriate delivery method
◉ Appropriate delivery method
○ Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

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Issue 6: Risk Management/Allocation

This issue concerns methods for coping with the uncertainties that are inherent in each project delivery method. The overarching goal should be to select the project delivery method that does the best job of allocating project risks to the parties in the best position to manage them.

Advantages/Disadvantages Form—Risk Management/Allocation

Design-Bid-Build (DBB)		
❒ DBB provides historically well-defined and well-understood risk allocation.		
❒ Prescriptive designs and specifications allow for greater detail in risk allocation.		
❒ Constructor cannot participate in risk management or risk allocation decisions during design.		
❒ Conflicts can exist in risk allocation between separate design and construction contracts.		
❒ Constructor's ability to manage risk is constrained by low-bid procurement.		

Construction Manager at Risk (CMR)		
Use Statement		
❒ Construction manager understands and participates in risk allocation and the management process during design.		
❒ Prescriptive designs and specifications allow for greater detail in risk allocation.		
❒ Risk management process can be more complex due to separate design, construction, and construction management contracts.		
❒ Risks for costs can be shared by the construction manager and the airport through the use of a GMP structure.		

Design-Build (DB) Please specify procurement system		
❒ Single point of responsibility for risk management in design and construction.		
❒ Design-builder owns risk for design errors and omissions.		
❒ Risks must be allocated through conceptual design and performance specifications, so the owner may lose some ability to participate in the risk management process.		
❒ Risks for costs can be shared by the construction manager and the airport through the use of a GMP structure.		
❒ Airport risks for scope creep and cost growth can be transferred to the design-builder through best-value, fixed-price procurement.		

Table 4-9. Risk management/allocation advantages/ disadvantages summary.

Issue	DBB	CMR	DB
6. Risk Management/Allocation			

Key: ● Most appropriate delivery method
◘ Appropriate delivery method
O Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

Issue 7: Lifecycle Costs

Delivery methods can influence costs in the operation and maintenance phase. This issue focuses on the opportunities or barriers that each delivery method provides with regard to lifecycle costs.

Advantages/Disadvantages Form—Lifecycle Costs

[illegible]		
❒ The airport can control lifecycle costs through completed design and performance specifications. ❒ There is little opportunity for constructor input into lifecycle costs.		

Construction Manager at Risk (CMR)		
❒ CMR has all the benefits of DBB, plus the airport can leverage the construction manager's input into lifecycle costs. ❒ If CMR is employing a fast-track schedule, lifecycle costs may be difficult to address in detail. ❒ If lifecycle performance criteria are not well understood during the development of the GMP, lifecycle issues may be difficult to incorporate into the final product.		

Design-Build (DB) Please specify procurement system: (		
❒ The airport can use performance criteria to set lifecycle performance standards and rely on design-builder innovation to achieve these standards. ❒ If lifecycle issues are difficult to define through performance criteria, a GMP pricing structure could allow for more owner input than a fixed-price option.		

Table 4-10. Lifecycle costs advantages/disadvantages summary.

[illegible]			
7. Lifecycle Costs			

Key: ● Most appropriate delivery method
◘ Appropriate delivery method
○ Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

Issue 8: Maintainability

As with lifecycle issues, there can be advantages and disadvantages to each delivery method with regard to how maintainability is achieved. This issue concerns these advantages and disadvantages as they relate to the owner's ability to specify quality and ease of maintenance.

Advantages/Disadvantages Form—Maintainability

Design-Bid-Build (DBB)		
Issue Statement	Advantage	Disadvantage
❒ The opportunity to view completed plans before award allows airports to review maintenance issues in designs.		
❒ There is little opportunity for constructors to have input into maintenance issues.		

Construction Manager at Risk (CMR)		
❒ CMR has all the benefits of DBB, plus the airport can leverage the construction manager's input into maintenance issues.		
❒ If CMR is employing a fast-track schedule, maintenance issues may be difficult to address in detail.		
❒ If maintainability issues are not well understood during the development of the GMP, they may be difficult to incorporate into the final product.		

Design-Build (DB) Please specify procurement system: ( )		
❒ The airport can use performance criteria to set maintainability performance standards and rely on design-builder innovation to achieve these standards.		
❒ The airport can emphasize maintainability issues through performance criteria and best-value award factors.		
❒ If maintainability issues are not well understood at the procurement stage, they will not be incorporated into the DB contract.		
❒ Some DB contracts can incorporate maintenance warranties from the design-builder.		

Table 4-11. Maintainability advantages/ disadvantages summary.

Issue	DBB	CMR	DB
8. Maintainability			

Key: ● Most appropriate delivery method
◎ Appropriate delivery method
○ Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

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Airport-Level Issues

Issue 9: Airport Experience/Staff Capability

This issue mainly concerns the airport's experience, its staffing requirements, and its ability to properly administer alternative delivery methods.

Advantages/Disadvantages Form—Airport Experience/Staff Capability

Design-Bid-Build (DBB)		
Issue Statement		
❒ Since this is the traditional method of project delivery, owners will likely have the most experience with this method. ❒ As projects grow in size, more experienced staff is required. ❒ Owners typically have different staff to oversee design and construction processes. ❒ DBB typically requires a larger owner staff than CMR or DBB.		

Construction Manager at Risk (CMR)		
Issue Statement		
❒ CMR is similar to DBB in many key areas in which airports have experience (e.g., separation of design and construction). ❒ The CMR can augment an owner's capabilities with his own staff. ❒ Airport experience is needed with GMP pricing or when negotiation is difficult. ❒ Airport experience is needed in the use of multiple bid packages to facilitate fast-track construction. ❒ The CMR alternative can use fewer owner staff than DBB if the CMR is allowed to take on the traditional owner tasks.		

Design-Build (DB) Please specify procurement system: (		
❒ Airports can take advantage of the sole point of responsibility for design and construction to leverage their experience.		
❒ DB can reduce the overall number of required owner staff when compared to DBB or CMR.		
❒ DB can create peaks in owner staffing needs, particularly during procurement and design review periods.		
❒ While fewer owner staff is needed, more experienced staff is required.		
❒ Airport experience is needed in the area of developing procurement documents and performance criteria.		
❒ If a GMP is used, airport experience is needed with GMP pricing or when negotiation is difficult.		
❒ Airport experience is needed in the area of administering DB contracts, particularly in the area of design review and administration.		
❒ DB necessitates experienced staff to manage design and construction under one contract.		

Table 4-12. Airport experience/staff capability advantages/ disadvantages summary.

Factor	DBB	CMR	DB
9. Airport Experience/Staff Capability			

Key: ● Most appropriate delivery method
O Appropriate delivery method
O Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

Issue 10: Airport Control of Project

An airport's ability to control the details of design and construction varies with each project delivery method. (Note that cost control and time control are described in other issues.)

Advantages/Disadvantages Form—Airport Control of Project

[illegible]-Build (DBB)		
❒ The use of prescriptive specifications and complete designs at the time of award provides airports with the most control over the project. ❒ Separate design and construction contracts provide clear checks and balances. ❒ With additional control can come added activities and responsibility for airport staff.		

[illegible]		
❒ The CMR method benefits from early constructor involvement and also has the benefit of separate design and construction contracts that give an owner control over design details. ❒ Airport control of CMR delivery requires more effort due to the use of multiple design packages and the need for a GMP pricing structure.		

Design-Build (DB) Please specify procurement system: ( )		
❒ The transfer of design liability lessens the need for airport control over design. ❒ Award at a conceptual design level may mean that the airport will lose control over the details of the final design depending on the owner involvement program. ❒ Use of QBS and a GMP pricing structure can give the airport more control if it is willing to fix the GMP in the later stages of design development.		

Table 4-13. Airport control of project advantages/ disadvantages summary.

Issue	DBB	CMR	DB
10. Airport Control of Project			

Key: ● Most appropriate delivery method
◘ Appropriate delivery method
○ Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

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Issue 11: Security

Security imposes another level of technical complexity and a potentially high level of liability on all airport projects. Airport security affects both the design phase and the construction phase. This issue concerns the multiple effects of security requirements on airport projects and how each project delivery method is impacted by and impacts security requirements.

Advantages/Disadvantages Form—Security

Design-Bid-Build (DBB)		
❒ DBB offers the highest level of flexibility to the owner during the design phase. ❒ The low-bid award can make security-related changes difficult to negotiate during construction.		

Construction Manager at Risk (CMR)		
❒ The ability of the CMR to work with the designer can allow for efficiency and flexibility in addressing security issues. ❒ The point at which the GMP is negotiated can influence efficiency and flexibility.		

Design-Build (DB) Please specify procurement system: ( )		
❒ The integration of designer and constructor can allow for efficiency and flexibility in addressing security issues. ❒ In a fixed-price DB process, security-related changes may be difficult to negotiate during construction. ❒ If a GMP is used, the point at which the GMP is negotiated can influence efficiency and flexibility.		

Table 4-14. Security advantages/disadvantages summary.

11. Security			

Key: ● Most appropriate delivery method
◎ Appropriate delivery method
○ Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

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Issue 12: Control of Impact on Passengers and Operations

This issue concerns the ability of each delivery method to allow the coordination of construction activities with airport operations management in order to minimize construction impacts.

Advantages/Disadvantages Form—Control of Impact on Passengers and Operations

❒ The airport's control over the design and construction packaging can help to minimize impacts on operation and passenger flow. ❒ Post-award changes in the construction schedule due to airport operations may be difficult to negotiate.		

❒ Additional CMR experience in design can help minimize impacts on operation and passenger flow. ❒ Having one CMR contract to oversee multiple bid packages may assist the airport in appropriately phasing the project to minimize impact. ❒ The airport and the CMR must have a clear understanding of roles and responsibilities with regard to these controls.		

Design-Build (DB) Please specify procurement system _____		
❒ DB provides a single source of responsibility for controlling the impact of the project on airport operations that can be tied to performance criteria in both the project's design and construction schedules. ❒ The airport will have less control over the constructor than in the other methods. ❒ If a GMP is used, the point at which the GMP is negotiated can influence the airport's input into operations.		

Table 4-15. Control of impact on passengers and operations advantages/disadvantages summary.

Issue	DBB	CMR	DB
12. Control of Impact on Passengers and Operations.			

Key: ● Most appropriate delivery method
◘ Appropriate delivery method
○ Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

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Issue 13: Third-Party Stakeholder Input to Design and Construction

This issue concerns each project delivery method's ability to promote coordination and project-specific agreements with third parties involved in the project or affected by it—political entities, utilities, adjacent communities, and so forth. This issue also concerns the opportunities afforded by the delivery method to the owner for coping with community input.

Advantages/Disadvantages Form—Third-Party Stakeholder Input to Design and Construction

Design-Bid-Build (DBB)		
❒ Separate design and construction phases provide an opportunity to get stakeholders' inputs before the commencement of construction. ❒ The use of complete plans and prescriptive specifications facilitates third-party agreements. ❒ The opportunity for stakeholder changes in design can cause delay in the project and add to the costs in the form of change orders. ❒ Expediting third-party agreements in the DBB process can be cumbersome if it is required.		

Construction Manager at Risk (CMR)		
❒ The construction experience of the construction manager can help facilitate stakeholder input. ❒ Construction managers can help facilitate third-party agreements. ❒ Stakeholder input can make GMP negotiation troublesome if not managed correctly. ❒ Construction managers typically do not guarantee costs that stem from problems with third-party agreements.		

Design-Build (DB) Please specify procurement system: (		
❒ The owner can require the DB contractor to include a public information and outreach program to facilitate communities' inputs. ❒ Design-builders can be innovative in helping gain community involvement. ❒ Any third-party change after the award of a fixed price or the negotiation of a GMP can be costly or difficult to negotiate. ❒ Design-builders can use innovative methods to assist in obtaining third-party agreements.		

Table 4-16. Third-party stakeholder input to design and construction advantages/disadvantages summary.

Issue	DBB	CMR	DB
13. Third-Party Stakeholder Input to Design and Construction			

Key: ● Most appropriate delivery method
◎ Appropriate delivery method
○ Least appropriate delivery method
X Not Applicable (discontinue evaluation of this method)

Comments _____

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Public Policy/Regulatory Issues

Issue 14: Competition and Local Talent

This issue concerns how each project delivery method affects the level of competition among potential bidders, especially whether or not a project delivery method leverages local competition.

Advantages/Disadvantages Form—Competition and Local Talent

Design-Bid-Build (DBB)		
❒ The airport benefits from a large pool of potential bidders and high level of competition. ❒ There may be issues that follow low-bid procurement such as a higher probability of request for change orders, disputes, and claims.		

Issue 16: Legal and Statutory Constraints

This issue concerns the interactions between each delivery method and governing regulations. Due to constant changes in state and local laws, airports should check all the relevant codes in order to determine the legality of each delivery method at the time when possible delivery methods are studied for a project.

Advantages/Disadvantages Form—Legal and Statutory Constraints

Design-Bid-Build (DBB)		
Issue Statement	Advantage	Disadvantage
❒ All states are authorized to use DBB. ❒ Labor agreements are generally not an issue. ❒ Open bidding procedures are typically not constrained by public law.		

Construction Manager at Risk (CMR)		
❒ Some states allow more flexible procurement regulations with CMR, which can be advantageous in appropriate situations to expedite project development. ❒ Some state airports are not authorized to use CMR or need to get extra approvals (see Step 3. Review Go/No-Go Decision Points).		

Design-Build (DB) Please specify procurement system: (		
❒ Some states allow more flexible procurement regulations with DB, which can be advantageous in appropriate situations to expedite project development. ❒ Some state airports are not authorized to use DB or need to get extra approvals (see Step 3. Review Go/No-Go Decision Points).		

Table 4-19. Legal and statutory constraints advantages/disadvantages summary.

Issue	DBB	CMR	DB
16. Legal and Statutory Constraints			

Key: ● Most appropriate delivery method
◘ Appropriate delivery method
○ Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

Issue 17: Sustainability and LEED Certification

Sustainable design is becoming ever more important in achieving overall sustainability goals for projects. This issue concerns project delivery method effects on achieving sustainable design goals (and, if the owner desires, LEED certification).

Advantages/Disadvantages Form—Sustainability and LEED Certification

Design-Bid-Build (DBB)		
❒ Airports can work with designers to incorporate sustainable designs into complete designs through prescriptive specifications. ❒ Airports can assume liability when prescribing construction methods. ❒ The process provides little opportunity for constructability reviews to ensure that sustainable designs can be constructed efficiently and are not cost prohibitive. ❒ There is little opportunity or incentive for the constructor to do more than what is specified in terms of sustainable construction practices.		

Construction Manager at Risk (CMR)		
❒ CMR has all the benefits of DBB, plus the airport can leverage the construction manager's input into sustainable design issues. ❒ The use of separate bid packages can create barriers in the integration of sustainable solutions if not approached correctly.		

Design-Build (DB)		
❒ The airport can emphasize sustainable design issues through performance criteria and best-value or QBS award factors. ❒ Integration of the design and construction team can enhance the constructability of designs. ❒ If sustainable design issues are not well understood at the procurement stage, they will not be incorporated into the DB contract. ❒ The airport may not be involved in all design decisions.		

Design-Build (DB) Please specify procurement system:		
Issue Statements	[illegible]	[illegible]
❒ The single source for design and construction eliminates claims for design errors or omissions from the airport's perspective.		
❒ There is a potential for claims with regard to scope definition if the form of the DB contract is not well understood.		
❒ The size and frequency of change orders are smaller in DB.		

Table 4-22. Construction claims advantages/ disadvantages summary.

Issue	DBB	CMR	DB
19. Construction Claims			

Key: ● Most appropriate delivery method
O Appropriate delivery method
○ Least appropriate delivery method
X Not applicable (discontinue evaluation of this method)

Comments _____

Step 5. Choose the Most Appropriate Project Delivery Method

Steps 1 through 4 of the selection process provide all the individual pieces of information to make a project delivery decision. The final step involves combining this information into a final comprehensive format that will aid in making the decision. Table 4-23 presents a form in which to summarize the advantages and disadvantages of each project delivery method with regard to each of the issues. Step 5 requires the following actions:

- **Review project goals.** Review the project goals documented in Step 2 to be certain that any project delivery method selection is in alignment with these goals.
- **Transfer issue summary ratings.** Transfer each of the 19 individual issue summary ratings (documented in the Issue Summary Table at the end of each issue analysis) to Table 4-23 to provide a complete picture of the analysis.
- **Review Table 4-23 to determine the dominant delivery method.** Upon completion of Table 4-23, a delivery method may emerge as dominant. A dominant delivery method will contain a large number of "most appropriate" ratings in areas that align with the project goals. A dominant method will also have few or no "least appropriate" ratings. **Counting or translating the ratings should be avoided.** If needed, review any comments from the pertinent issue analysis (see Chapter 3) to help with the delivery decision. Note: If a dominant method exists, make a project delivery choice and move to Step 6.

Table 4-23. Project delivery method advantage/ disadvantage summary.

	DBB	CMR	DB
1. Project Size/Complexity			
2. Schedule Compression			
3. Schedule Growth Control			
4. Early Cost Precision			
5. Cost Control			
6. Risk Management/Allocation			
7. Lifecycle Costs			
8. Maintainability			
9. Airport Experience/Staff Capability			
10. Airport Control of Project			
11. Security			
12. Control of Impact on Passengers and Operations			
13. Third-Party Stakeholder Input to Design and Construction			
14. Competition and Local Talent			
15. DBE/Small Business Impacts			
16. Legal and Statutory Constraints			
17. Sustainability and LEED Certification			
18. Adversarial Relationships			
19. Construction Claims			
Other			

Key:
- ● Most appropriate delivery method
- ◘ Appropriate delivery method
- ○ Least appropriate delivery method
- X Not Applicable (discontinue evaluation of this method)

Project Delivery Advantages and Disadvantages Summary

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- **Review "least appropriate" ratings.** Review any "least appropriate" ratings to determine whether any of the issues raised red flags or problems that would make a delivery method significantly less desirable.
- **Choose the delivery methods to Study in Tier 2.** If a dominant method is not apparent, remove any inappropriate methods, document the decision as described in Step 6, and move to Tier 2 for a more detailed analysis.

Step 6. Document Results

The final step in the Tier 1 approach is to document the results in a Project Delivery Decision Report. Whether one delivery method emerges as the dominant choice or none of the three delivery methods are eliminated from consideration in the process, documentation is a vital step. Documentation will assist in developing procurement and contracting strategies for the ultimate project delivery method. It will also serve to communicate the project delivery choice to interested stakeholders.

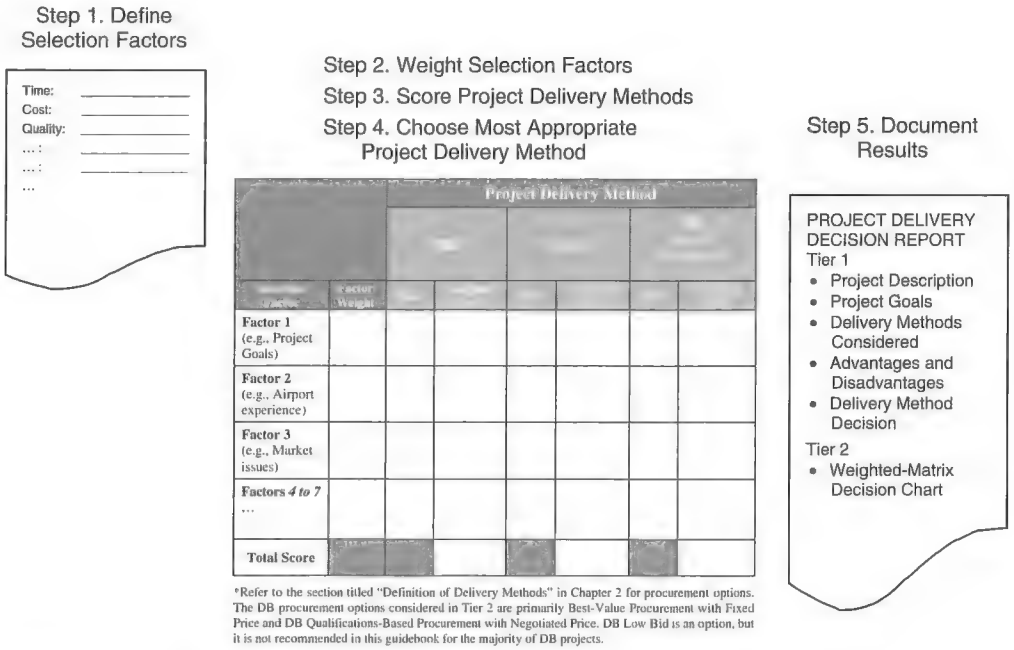

Figure 5-1. Tier 2 approach overview.

Step 3. Score Project Delivery Methods
Step 4. Choose Most Appropriate Project Delivery Method
Step 5. Document Results

Step 1 of the Tier 2 process begins by defining a concise set of selection factors. These selection factors consist of the project goals and any of the pertinent issues examined in the Tier 1 approach that were deemed critical (see Chapter 4 for the Tier 1 approach). The Tier 1 approach asks airports to establish their project goals at the beginning of the process. The first step in Tier 2 is for airports to develop a concise set of selection factors by combining their project goals with the most relevant of the 19 pertinent issues examined in Tier 1. These selection factors will be used throughout the Tier 2 approach.

In Step 2, airports rank and then weight selection factors. Some selection factors may overlap with others, in which case they can be combined. Other selection factors may stand alone for analysis. Completion of Step 2 results in a list of up to seven selection factors for further analysis.

Step 3 of the Tier 2 approach requires airports to score each delivery method in terms of the selection factors. A further examination of the advantages and disadvantages for each delivery method will form the basis for these scores. Since the scores will be subjective, airports will need to be diligent in documenting the rationale for the scores.

Step 4 involves a determination of the most appropriate delivery method through the completion of the weighted-decision matrix. Airports will make the determination by multiplying the selection factor weights by the project delivery scores and then summing the values for each delivery method. The highest score will indicate the best choice. However, since the scores will be subjective, airports are encouraged to review the totals to determine whether the values are logical and defensible.

The objective of Step 5 is to supplement the Project Delivery Decision Report developed in Tier 1. The Tier 1 report will provide a project description, project goals, delivery methods considered, advantages and disadvantages, delivery method decision, and any relevant appendices. The Tier 2 documentation will add the weighted-decision matrix to the Tier 1 documentation to sup-

plement the archival record of the project delivery decision. The Project Delivery Decision Report will serve to communicate the decision to interested stakeholders and to justify the decision if issues arise years later, after the project is completed.

The five steps of the Tier 2 approach are discussed in more detail below. In this report, to better illustrate how the Tier 2 approach works, the selection of a delivery method for an example project is followed through the first three steps of the Tier 2 analysis. Following the description of Steps 1, 2, and 3 in the Tier 2 approach is an illustration of how each step was handled in the delivery selection process for the example project.

Step 1. Define Selection Factors

As stated in Step 1 of the Tier 1 approach, understanding and communicating a concise set of project goals is perhaps the most important element in selecting an appropriate project delivery method. The definition of project goals is a key success factor not only in the project delivery decision, but also in the development of procurement documents and the administration of a project. It is the project performance goals (e.g., time, cost, quality, maintainability, and sustainability) that typically drive the project delivery decision.

The first step in the Tier 2 approach requires airports to combine the project goals and pertinent issues into a set of selection factors for use in the weighted-decision matrix. This step requires a review and filtering of the project goals and pertinent issues for use as selection factors. Figure 5-2 depicts this process.

To create the goal-based selection factors, airports should review the project goals that were established in Tier 1. The Tier 1 review of the delivery method advantages and disadvantages may have revealed overlaps or gaps in the originally established project goals. While the original project goals should not change, these overlaps and gaps will need to be removed for the development of the Tier 2 selection factors. Step 1 in the Tier 2 approach allows and encourages editing of these goals as they are rewritten into selection factors. In developing selection factors from the project goals, airports should consider the following questions:

- Are there significant overlaps in the project goal statements that can be revised to make them more independent?

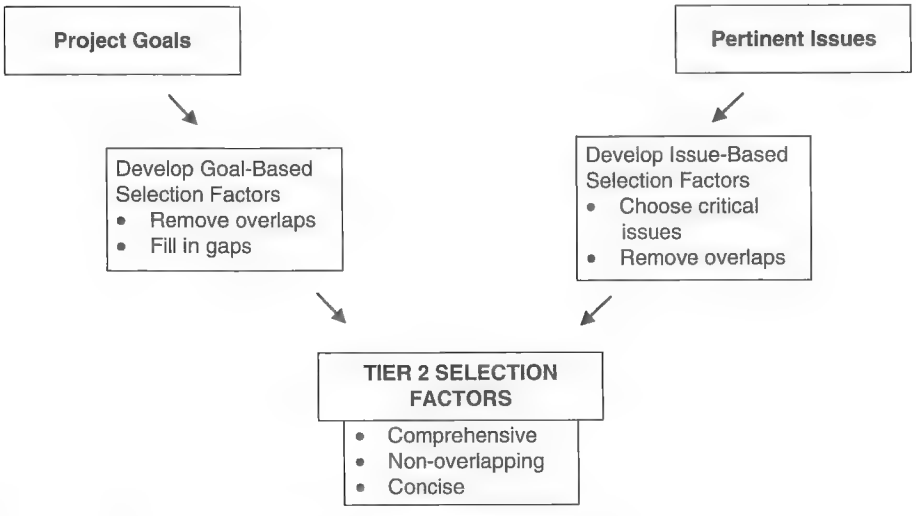

Figure 5-2. Tier 2 selection factor development.

Table 5-2. Project delivery scoring scale.

10	The evidence that the delivery method positively aligns with the project objective or issue is of the highest possible order of affirmation.
8	The delivery method strongly aligns with the objective or issue and is demonstrated in practice. There is a slight risk that the objective or issue may not be beneficial.
6	Experience and judgment point to the delivery method strongly aligning with the objective or issue. There is a mild risk that the objective may not be beneficial.
4	Experience and judgment slightly point to the delivery method aligning with the objective or issue. There is a strong risk that the objective will be negatively affected.
2	There is little benefit to applying the delivery method for this goal or objective. There is a strong likelihood that the object will not be achieved.
9,7,5,3,1	Intermediate values between two adjacent judgments.

(Adapted from Saaty 1990.)

team to come to a decision by consensus. The rationale for each individual score should also be carefully documented. Consideration should also be given to the relative scores for each delivery method to ensure consistency.

Similar to the development of factor weights, the scoring can be done simply through a group discussion among key airport team decision makers.

Table 5-3 provides a weighted-matrix template. The matrix shown contains three delivery methods. However, a larger or smaller number of delivery methods can be analyzed, depending upon the results of Tier 1. For example, two types of DB delivery methods with various procurement

Table 5-3. Weighted-matrix template.

		Project Delivery Method					
Selection Factor	Factor Weight						
Factor 1 (e.g., Project Goals)							
Factor 2 (e.g., Airport experience)							
Factor 3 (e.g., Market issues)							
Factors *4 to 7* …							
Total Score							

*Refer to the section titled "Definition of Delivery Methods" in Chapter 2 for procurement options. The DB procurement options considered in Tier 2 are primarily Best-Value Procurement with Fixed Price and DB Qualifications-Based Procurement with Negotiated Price. DB Low Bid is an option, but it is not recommended in this guidebook for the majority of DB projects.

methods could be competing in this matrix. The matrix can also contain up to seven selection factors for each project.

The result of Step 3 will be a scored ranking of the delivery methods in question. The delivery method with the highest total score will be the most appropriate method for the given project.

The next steps involve documenting the individual scores, making a decision, and creating a Project Delivery Selection Report.

Delivery Selection for the Example Project—Step 3. Table 5-4 shows how an airport might score the project delivery methods for the example project. Note that only the CMR and DB project delivery methods made it through the Tier 1 filter for further consideration in Tier 2. Also note that the scores in the example below are project dependent and will certainly change from project to project.

Explanations of the scores for the project delivery methods for the example project are the following:

- **Project completion factor.** The project completion factor relates to a project goal. In this case, the project has a fixed end date of November 1, 20XX. The airport believes that the completion date can be achieved with CMR delivery. The airport also believes that CMR will require the use of multiple bid packages to achieve the schedule, which adds a risk for meeting the schedule date, so CMR = 6 (in this case). DB delivery provides for a single entity to coordinate design and construction. DB also allows for an airport to specify a fixed end date in the procurement documents and the contract. According to what has been demonstrated in practice, the airport is confident that the end date can be achieved through a DB delivery, so DB = 8 (in this case).
- **Cost containment factor.** The cost containment factor relates to a project goal. The project has a maximum budget of $200 million. DB delivery has demonstrated in practice that a fixed price can be negotiated early in the project development process. It has also been demonstrated that DB provides the lowest average cost growth of the two methods in question, so DB = 8 (in this case). CMR also provides the ability to meet a fixed price, but the airport is not as confident that it will be able to negotiate a fixed price as early in the process as it can with DB, so CMR = 6 (in this case).
- **Impact on passengers and operations factor.** This factor stems from a pertinent issues analysis in Tier 1. The project involves work on an operating airport. The airport desires to keep operations and passengers flowing smoothly throughout the construction of the project. In this case, the airport has met with designers who can help define operational goals that can be

Table 5-4. Weighted matrix for the example project.

		Project Delivery Method			
Selection Factors	Importance Weight				
Project complete by November 1, 20XX	50	6	300	8	400
Cost not to exceed $200 million	25	6	150	8	200
Minimize impact on operations and passengers during construction	15	10	150	6	90
Minimize staffing requirements during design and construction	10	8	80	6	60
Total Score	100		680		750

CHAPTER 6

Conclusion

This guidebook was prepared with the objective of providing a systematic and logical approach for selecting the most appropriate delivery method for an airport project. Furthermore, this guidebook aims to help the user in documenting the process of decision-making in a Project Delivery Decision Report. It is recommended that airports with limited resources or those with no experience with alternative delivery methods use industry professionals from outside the airport to facilitate the implementation of this methodology. These professionals should have a thorough understanding of and experience with the type of project the airport is evaluating, the various project delivery methods the agency is considering, and the potential risks associated with the type of project and various project delivery methods under consideration. The use of such professionals will ensure that the appropriate expertise and experience are incorporated into the process.

The delivery methods considered in this guidebook are the traditional design-bid-build (DBB), construction manager at risk (CMR) or construction manager/general contractor (CM/GC), and design-build (DB). Until recently, the traditional DBB approach was the project delivery method most commonly chosen by airports, mainly due to legal limitations and airport experience with this delivery method. Legal limitations have been removed to a large degree, and this has provided more flexibility in the choice of project delivery and contracting methods. The interviews conducted in this research with nine airports of diverse sizes and geographical locations showed that the use of alternative project delivery methods is still an evolving practice in the airport industry; thus, the subject of this research project—furnishing guidance on selection of a project delivery method—is not only important but also very timely.

Airports have different motivations in selecting an alternative project delivery method. The research team found that no single project delivery method was superior to all others and that airports need to carefully analyze the characteristics of each project to find the project delivery method most suitable to meeting that project's requirements. The most common reasons given by airport executives interviewed for this research for choosing a specific alternative project delivery method were as follows:

1. Project schedule issues,
2. Project monetary size,
3. Project technical complexity,
4. Whether or not the project will generate revenue,
5. Project budget control issues, and
6. Incentive for obtaining federal or state funding.

Airport agencies should carefully study the risks, costs, and benefits associated with each project delivery method in the context of the project under consideration and select the project delivery method that best suits the legal, technical, and business environment in which the project must be built. This guidebook strives to facilitate this process by providing a two-tiered delivery

selection system that covers all these factors. In this system, the user works through the two tiers sequentially and narrows down the viable delivery methods through a process of eliminating the inferior choices.

In the Tier 1 approach, users evaluate the viability of each delivery method against a number of pertinent issues that can be of vital importance to the project's success in achieving its goals and objectives. Among the pertinent issues that affect the project delivery decision, there are certain issues that may render one or more delivery methods inappropriate. These issues involve project schedule constraints; federal, state, and local laws; and third-party agreements. The airport needs to review these issues to determine whether they eliminate any of the delivery methods. In other words, the agency should make a go/no-go decision based on these issues.

Following the go/no-go decision, the user examines the remaining project delivery choices against the larger list of pertinent issues and rates each delivery method based on its advantages and disadvantages in relation to each pertinent issue. The summary of these ratings is compiled in a table and analyzed to determine whether a decision on a delivery method can be made based on the overall capabilities of competing delivery methods in dealing with these pertinent issues. If a clear winner emerges at this point, a Project Delivery Decision Report can be generated that describes the reasons for the choice of delivery method.

If more than one delivery method remains viable after completing the Tier 1 approach, the user should move on to the Tier 2 approach. In Tier 2, a select subset of goals and pertinent issues are identified as "selection factors" that are of profound importance to the airport. Each selection factor is weighted according to instructions provided in this guidebook, and an overall score is computed for each delivery method. Again, a report documenting the decision-making process can be generated.

This guidebook was reviewed by several airports. The users found the process easy to follow and informative, and the overall assessment was very positive. Their comments and feedback were carefully reviewed and incorporated into the current guidebook. The guidebook in its current form is a valuable tool for airports, especially those with limited experience with alternative project delivery methods.

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APPENDIX B

Definitions of Terms

Agency Construction Management (CM): Agency CM is a professional service where the Construction Manager acts as the owner's agent in managing the construction project. Its role is consultative, and the CM is usually not at risk for the cost and schedule of building the project.

Analytical Delivery Decision Approach: A method of project delivery selection that examines the advantages and disadvantages of various project delivery methods to arrive at an appropriate method for an individual project. In this guidebook, this method is Tier 1 of the Project Delivery Selection System.

Best-Value Procurement System: A procurement process where price and other key factors are considered in the evaluation and selection process to minimize impacts and enhance the long-term performance and value of construction.

Construction Manager at Risk (CMR) or CM/GC: In this guidebook, CMR and CM/GC are equivalent terms. The owner holds two separate contracts with the construction manager at risk (sometimes referred to as the *General Contractor*) and the designer of the project. The CMR is chosen based on criteria other than just the lowest construction cost, such as qualifications and past performance. In this delivery method, the CMR is held to a *guaranteed maximum price* (GMP). The CMR typically provides constructability, cost, schedule, and value engineering input during the project design phase.

Constructor: The constructor is the entity that contracts with the project owner to execute the construction phase of the project. In the Design-Build approach, the constructor is also responsible for the final design.

Contracting/Reimbursement Techniques: The mechanics of how an owner will compensate the providers of the design and construction services in the project. These include but are not limited to GMP, cost plus, negotiated lump sum, and firm fixed price methods.

Design-Bid-Build (DBB): This is the traditional method of delivering a project in which design and construction are contracted with two separate entities.

Design-Build (DB): A project delivery method in which the owner procures both design and construction services in the same contract from a single legal entity referred to as the design-builder.

Go/No-Go Decision Points: A critical issue or decision point that excludes a project delivery method from further consideration is called a Go/No-Go Decision Point.

Guaranteed Maximum Price (GMP): This is a price mechanism in which the owner is committed to reimburse the project costs up to a predetermined ceiling. Any cost overrun above that ceiling is a risk taken by the constructor.

Low Bid: The services required are awarded on the basis of price alone. There is no other consideration, except financial responsibility, which is usually defined by the ability to furnish a performance bond

Management Options/Techniques: The approaches available to an owner to administer the project's design and construction. These generally revolve around the ability of in-house resources to furnish the necessary oversight or the decision to assign those responsibilities to a consultant such as an Agency CM or a program manager.

Pertinent Issues: The term "*pertinent issue*" refers to 19 critical issues identified and explained in this guidebook that influence the selection of the project delivery method.

Procurement/Selection Systems: The method by which the owner will identify proposers and award contracts to furnish the design and/or construction services. These are generally restricted to forms of low bid (100% price-based), qualifications-based selection (no price considerations) and best-value (includes price and other factors such as qualifications, schedule, design approach, etc.).

Project Delivery Decision Report: This is an archival report that communicates and justifies an individual project delivery decision to interested stakeholders.

Project Delivery Method: The project delivery method (or project delivery system) is the process by which a construction project is comprehensively designed and constructed for an owner. It refers to all the contractual relations, roles, and responsibilities of the entities involved in a project.

Project Delivery Selection System: This is the decision support system developed in this guidebook consisting of two tiers (analytical and weighted matrix) to help airport agencies select the most suitable delivery method for their projects.

Project Goals: Project goals are statements of technical or performance objectives that communicate the importance of project issues such as time, cost, quality, maintainability, and sustainability.

Project Lifecycle: Project lifecycle is the duration that starts at project germination and includes project conceptual, preliminary, and detailed design as well as the procurement and construction phases. It ends at the end of the project operation and maintenance phase.

Project Stakeholder: Any individual or entity that has an interest in a project that may be directly involved in the project (e.g., the designer or contractor) or be affected by the project completion (e.g., communities or business owners adjacent to or affected by the airport) is a *project stakeholder.*

Qualifications-Based Selection (QBS): Contract is awarded on the basis of qualifications alone. Price is not considered.

Selection Factor: A variable in the Weighted Decision Matrix (Tier 2 of the proposed Project Delivery Selection System) that is derived from the project goals and critical issues to aid in the project delivery method decision is referred to as *selection factor.*

Weighted Decision Matrix: This is a decision process that organizes selection factors in the rows of a matrix and project delivery methods in the columns to structure a project delivery method decision. The selection factors are weighted by their importance to the project goals and scored by their alignment with each project delivery method. The weighted selection factors are summed up for each project delivery method for making the final decision.

APPENDICES C THROUGH F

To find Appendices C through F of this guidebook, go to www.trb.org and search for "ACRP Report 21". Titles of Appendices C through F are the following:

Appendix C: Forms for Project Description and Goals

Appendix D: Forms for Analytical Delivery Decision Approach (Tier 1)

Appendix E: Forms for Weighted-Matrix Delivery Decision Approach (Tier 2)

Appendix F: Case Study Example: Logan International Airport Central Parking Garage

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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